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BULLOCKS' HIDE BOATS.

AMONG the sketches sent home by officers of the British Army now in Afghanistan is one here given, which we find in the *Illustrated London News*. It illustrates a boat or raft made of bullocks' hides, inflated with air. The hides are lashed together and to the floor, the whole forming a buoyant but safe form of conveyance. The engraving is from a scene on the Cabul River, with a party of English antiquarians on a visit to the famous caves in the banks of the river.

THE WILDERNESS AT THE HEAD OF THE MISSOURI, COLUMBIA, AND COLORADO RIVERS.

By CHARLES F. BLACKBURN.

HAVING spent the greater portion of the past two years prospecting in the country lying about the head waters of the Yellowstone and the other great rivers that have their sources in the Wind River Mountains, I send herewith for publication in the *Press* some hastily prepared remarks on the region so traversed and explored, and some portions which had probably not before been passed over by any white man. Though mainly in search of metalliferous deposits, I found much in the other natural products of that vast wilderness, as well as in its geology, scenery, and other physical features, calculated to interest both the practical and scientific mind.

THE BIG HORN MOUNTAINS—GEOLOGY AND TOPOGRAPHY.

Touching the geology of the country in the vicinity of the Big Horn Mountains, it may be observed that the usual calcareous and arenaceous rocks are here found, varying in geological ages from the azoic to the tertiary deposits. Many of these strata are highly fossiliferous, including a great variety of fossils of aquatic origin. No fossil fauna was seen near the base of the range, but east of the mountains in the lignitic tertiary beds the remains of petrified mammals were noticed. The stratum of the carboniferous age occurs on both sides of the range near its base, both anthracite and bituminous coal being found in abundance. Mountain limestone or the sub-carboniferous strata envelop the mountains to an elevation of 2,000 feet above the base, where they break down abruptly to the azoic rocks; thus the crystalline rocks appear at an altitude of 9,000 feet above the ocean, and compose the more elevated parts of the range. Near the summit a compact, fine-grained grayish granite predominates, which is occasionally varied by belts of gneiss and patches of mica schist. At the south end of the range, at its junction with the Rattlesnake range, mica and talcose slate are found traversing the granite rocks. But little quartz occurs on the western slope, either *in situ* or as float. The eastern slope, however, shows considerable quartz in well-defined ledges, usually of a gray color and often ferruginous. Some of these lodes proved to be auriferous, but the gold was in such small quantities generally as to not defray expenses of mining. The highest elevations in the Big Horn Range are Cloud peak and Hayes peak, which reach an altitude of 13,500 feet. Several other peaks reach an altitude above 13,000 feet. The length of the crystalline rocks of this range is 200 miles, their greatest width, which is at Cloud Peak, being 25 miles. The range is severed at the north end by the grand canyon of the Big Horn River, which presents a scene of rugged grandeur, with its walls standing vertically fully 3,000 feet high. The length of this canyon is nearly 40 miles, and for sublimity and picturesqueness of scenery, it rivals that of the famous grand canyon of the Yellowstone, in the National Park. In the Big Horn Mountains colors of gold can be obtained from nearly all the streams, especially from an alluvial deposit of quartz wash around the foot-hills. This deposit shows infinite attrition, and is evidently not indigenous to the crystalline rocks of the Big Horn range. This foreign deposit in all cases proved to be auriferous, which is not always the case with the original deposits from the crystalline rocks of this range. Taking these facts into consideration, I arrive at the conclusion that the gold found about the Big Horn is not all from that range, but that most of it is derived from this ancient wash, which I subsequently traced to the head of Wind River through Union Pass and down the Snake. The idea was generally entertained by our prospecting miners that the fine color of gold found around the base of the Big Horn range came originally from some auriferous belt in those mountains. We are now in possession of geological evidence, however, that disproves this theory. Gold in small or even paying quantities may yet be found in these mountains, but extensive deposits can hardly exist there without showing some indications of its entity.

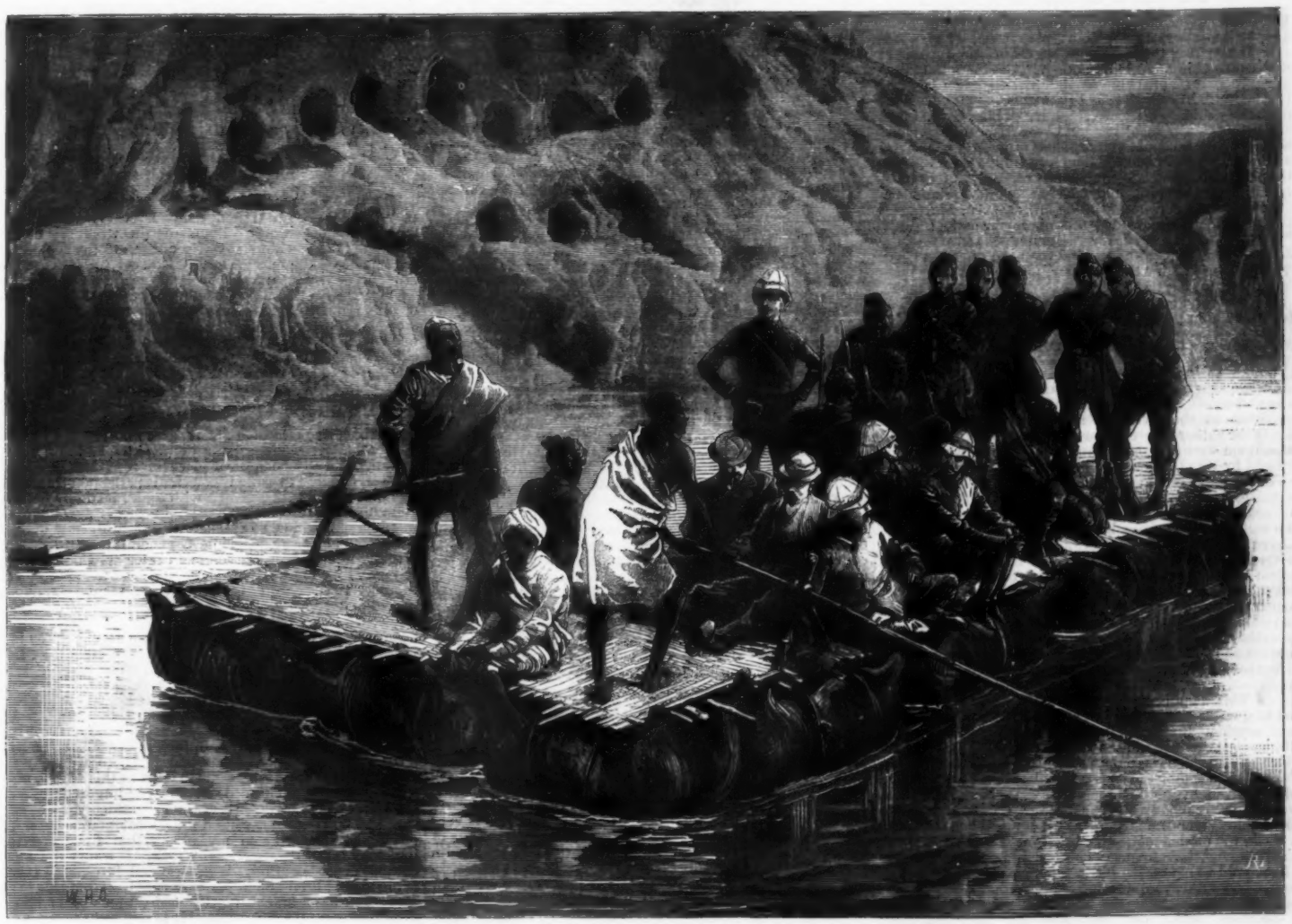
METAL DEPOSITS OF THE SNOW MOUNTAINS.

In the SNOW Mountains, between Clark's fork and the Yellowstone, indications are more favorable both for gold and silver. The original rocks here are as follows: Gneiss, granite, syenite, trachyte, porphyry, mica, and talco slate; while along the southwest base volcanic tufas occur. At the head of Soda Butte creek argentiferous galena is found, which yields a fair percentage of silver. Some of these deposits are being developed by Judge Annis and others. Auriferous ores are found *in situ* on Emigrant and Bear gulches, also fair indications on Hell-Roaring creek. On the northern slope extensive deposits of native copper occur near some trap dikes. Below the canyon of Clark's fork some interesting fossiliferous deposits exist in the calcareous sedimentary rocks. The strata here upturned vertically present to view the organic remains of past ages in such bold relief as should make this an entertaining field for the geological scientist. Both vertebrate and invertebrate remains were noticed here at various points. Several peaks in this Snow range reach an altitude of 13,500 feet. Conspicuous among these towers the Russian Crown, with its snowy crest bearing incipient glaciers, and veiled in the shroud of perpetual congelation; a fit home for the ice king.

SIERRA SHOSHONE MOUNTAINS.

The Sierra Shoshone range begins at the head of Soda Butte creek and extends south to the head of Wind River, a distance of about 150 miles. Pretty thorough observations and prospecting were made here. The geological formation consists principally of volcanic rocks, basaltic and doleritic lavas, andesite and lava tufas, or a kind of volcanic conglomerate. On the South fork of Stinking Water a belt of gneissoid granite exists, containing many ledges of base ores, but no metalliferous deposits of value. At the mouth of the lower canyon, near an offensive smelling sulphur spring (from which the name Stinking Water originated), I found as much as 25 cents to the pan on bed-rock, but only in very limited quantity; origin evidently in the lower canyon range from quartzose, granitic rocks, or silicious granite.

At the head of the Middle fork of Clark's fork some cupriferous ores were obtained *in situ* near an extinct volcano. The deposits are argentiferous, and seemed inex-



BULLOCKS' HIDE BOATS ON THE CABUL RIVER, AFGHANISTAN.

tensive. On the North fork of Stinking Water colors of gold can be found; origin either from the trap rocks or the crystalline rocks, prior to the great trap eruption which has intruded on or capped the primitive rocks. Petrified wood was also found on this stream containing grains of iron (sideroferite). In this vicinity the mountains present a unique and striking scenery, the geological formation consisting of trap dikes, resulting from a great flow of lava which has here accumulated in mountain masses. Floods of water have subsequently cut through these with irresistible force, leaving isolated pinnacles and towers standing like great sculptured images. Showers of volcanic sand containing much oxide of iron have covered the tops of the strange objects, which, viewed from a neighboring height, look like gigantic columns standing amidst the ruins of a great city.

On the western slope of the Shoshone range volcanic glass is common, this substance being also found extensively in the National Park. Standing in this range are several peaks, having an elevation above 13,000 feet. Four extinct volcanoes were here discovered, from some of which the sulphurous gases are yet escaping, native sulphur being abundant in their craters. Among the noted elevations of this range are Index and Pilot peaks, and Mt. Langford and the Washakee Needles. The Owl Creek range is a spur of the Shoshone Mountains, which, with the Rattlesnake range, connects the Big Horn with the Shoshone Mountains. These two spurs are divided by the canyon of Wind River, their summits being only 9,000 feet high. Their trend is east and west, but the rocks are stratified in a northerly and southerly direction. The formation consists principally of metamorphic schistose rocks, quartz being also found in abundance. In panning the alluvial deposits colors of gold were obtained; also garnets, rubies, rutile, crystals of zircon, fragments of itacolumite, and other associated minerals found generally with diamond deposits; none of the latter crystals were, however, found, though their existence in this vicinity is not a geological impossibility. Owing to the inclement weather thorough explorations could not be made, but I shall resume operations in this field in the near future.

THE WIND RIVER MOUNTAINS.

The Wind River group of mountains may properly be termed the American Alps. This region is one of great interest as illustrating the marvelous effects of the dynamical force when used in mountain making. All along the range occur sharp spurs, narrowing as they rise till they seem as thin as a knife blade. Isolated peaks inaccessible to man; deep chasms filled with snow and ice, which never melt; alpine heights, awe-inspiring and wearing their glacial crowns in majestic silence; huge blocks of gneiss and granite hills are seen on every hand. The crystalline rocks at the north end of the range are composed principally of granite, gneiss, trachyte, syenite, and feldspar, while at the south end the slates appear. Here quite an extensive auriferous belt exists, which has afforded fair mining ground for several years. Gold also occurs on the numerous streams of the Wind River drainage. The water at the head of Green River is slightly tinged with a fine powder, produced by the moving glaciers crushing the rocks near the summit of the range. No gold was found on this stream in the mountains. The altitude of Union peak is about 13,000 feet.

GREEN RIVER—AN EXTENSIVE HYDRAULIC GOLD FIELD.

Although their elevation is not very great, these Wind River mountains constitute the grand divide of all our great continental rivers. Their southern slope is drained by Green River, while at their western base the Grosventre fork of Snake River gathers a great mass of water to be carried forward and emptied into the Columbia. Their northern slope is drained by Wind River, which, through the Big Horn and the Yellowstone, becomes tributary to the turbid Missouri. The greatest elevation in the Wind River Mountains is a peak lying southeast from Union, its height being a little over 14,000 feet above the ocean level. Several others near this one have an altitude nearly as great. Immense glaciers were discovered here, also perpetual frozen lakes, the ice being still firm in the month of August. Between the Grosventre and Buffalo fork of Snake River auriferous gravel exists, probably in paying quantities. The area of this auriferous tract is 20 miles wide and 40 miles long, and extends as far west as the Teton range. Being evidently an oceanic deposit, this wash shows infinite attrition, even the bowlders being polished by long transportation from their original situation —origin unknown, but evidently in the northwest mountain ranges. This wash is of variable depth and is wholly composed of quartz. The nucleus, or the rocks from which this quartz originated, especially that which accompanies the wash, has been reduced to sand by attrition, only the quartz having resisted pulverization. From the prospects obtained here I judge that much of this ground might be profitably worked by the hydraulic process, as water is plentiful, but it would not pay by any other method of handling.

The Snake River drainage has cut many canyons through this wash, the eroded matter having been carried down and deposited along that stream. This is doubtless the origin of the flour gold found on the lower Snake, which has afforded remunerative mining ground for a number of years. This great auriferous debris at the head of the river lies on lime and sandstone rocks. The deposition was made evidently prior to the upheaval of the main divide, as it caps the summit at Union Pass and extends down Wind River quite a distance. But it does not contain gold in such large proportions as the gravels of the Pacific slope. I would not advise miners to go to that country unless they possess sufficient capital to open and operate hydraulic grounds. In the Teton range the crystalline gold-bearing rocks abound, and some auriferous ores were here found *in situ*. Owing to the lateness of the season and the inclement weather, thorough exploration of that district could not be made, but I intend to return to it and determine its value for mining purposes. The Teton is one of the most wild and rugged ranges on this continent. Mt. Hayden and Mt. Moran are the highest elevations there, the former being the keystone of the range. This Alpine peak culminates at an altitude of nearly 13,900 feet, and is visible from nearly all parts of the National Park.

BAROMETRICAL OBSERVATIONS.

The following altitudes were noted in these several mountain ranges, with observations on vegetation, etc., between latitude 42° and 46° north: The main elevation only is given; the difference in the extremes between the north and south slopes of the mountains exceeding often 1,000 feet. Incipient evergreens, 6,000 feet above the ocean; limits of foliaceous trees, 9,500 feet; gramineous vegetation, 10,000 feet (which is also the limit of evergreen trees); foliaceous shrubbery, 11,000 feet; of evergreen shrubbery, 11,500 feet; limits of alpine flowers and herbaceous vegetation, 12,000 feet; perpetual frozen lakes and incipient glaciers, 13,000 feet; pseudo-meteoric dust or red snow (*palmella rosea* of the English writers) is visible at an altitude of 12,000 feet; glaciers of vast extent exist between 13,000 and 14,000 feet above the ocean, especially in the Wind River mountains. Close attention was given to timber line in this country, and wherever noticed I found trunks of dead trees above those of the living—unmistakable evidence of increasing cold. Another notable feature near timber line on the north slopes of the Wind River range, was that the trees, instead of standing vertically, are found leaning to the southeast, being occasioned by the terrible winds that blow here from the northwest.

ZOOLOGY.

The fauna of this country does not differ materially from that of other parts of the Rocky Mountains. Buffalo are found in large herds through the Big Horn Mountains, but they are being rapidly exterminated by the Indians. Elk and mountain sheep are very plentiful through all the ranges of the Yellowstone country, being generally found near the snow in the summer, where the grass is new and tender. The mountain goat (*Aplocerus montanus*) was not observed in any of the ranges, but has been reported by Indians to exist in the mountains farther north. Only two specimens of the moose were seen. Deer are very plentiful, antelope being generally found around the foothills and on the plains in large herds, also in the National Park. No gazelle were found here, but in the Black Hills before populated I shot several of this species of deer, they being numerous on the Belle Fourche river. Bear are very abundant in this region. In the Big Horn range I have seen as many as twenty in one day. They are of four kinds, generally known as the Rocky Mountain grizzly, cinnamon, black, and silver tip. Mr. H. R. Wormwood and myself on ascending a peak in the Sierra Shoshone range last July, saw ten bear at one sight, two of them which we shot. They were feeding on the ubiquitous grasshopper. The snow in these high altitudes is sometimes black with these insects, which get so thoroughly chilled after alighting that they are unable to fly away. The plaintive bleat of the little coney (*Lagomys princeps*) was heard on all sides, above an altitude of 10,000 feet, and, so far as I could ascertain, this rabbit lives at a greater elevation during the winter than any other animal. It was found in all the local ranges near the limits of vegetation. The mountain lion, wolf, coyote, lynx, and a great variety of the minor carnivorous genera inhabit this region. The chief fur-bearing animals indigenous here are the black and silver gray fox, otter, and beaver. Baird's rabbit (*Lepus Bairdi*) is met with in the Big Horn, Shoshone, and Snowy mountains. This interesting species was seen in the dense forests of the evergreen zone, about 8,000 or 9,000 feet high. The little chipmunk, as usual, was often around camp inspecting our provisions. The little water ousel we noticed along all the mountain streams, the little bird appearing to have a fondness for rushing torrents, cascades, and deep canyons, its twittering songs mingling harmoniously with the musical but thundering falls of water. Allan's finches (*Leucosticte australis*) were noticed in the Big Horn Mountains, near the limits of vegetation. The dusky grouse (*Tetrao obscurus*) is common, although not as numerous as Richardson's grouse. A great variety of aquatic fowls is noticeable in the lake regions of the Yellowstone and Snake rivers, the swan, pelican, gull, crane, loon, goose, and many kinds of ducks abounding here, where they remain during incubation in the summer months. The American eagle is very numerous around the Yellowstone lake, also its co-tenant the fish hawk. The Alpine insect fauna of these mountains is similar to that found in the ranges of Colorado; but owing to the paucity of vegetation insects do not thrive here at as great an altitude as they do further south, where lichens and flowers are more abundant. Very little insect life could be found here above timber line. On the highest peaks no organic life of any description was visible. I really suppose the pole itself presents hardly a more barren and frigid scene of desolation than these glacial peaks. Along the east base of the Big Horn range we meet with a fine agricultural country, having an average altitude of 6,000 feet. The climate is very healthful, and the country blessed with a cool and bracing atmosphere. The upper tributaries of the Big Horn, Yellowstone, Snake and Green rivers, are unfit for agricultural purposes, owing to their altitude and roughness. Some spots are, however, fit for grazing and stock rearing.

THE NATIONAL PARK.

As most of your readers are probably somewat acquainted with the topography of this spot, I will confine my description thereof to merely a synopsis. This great wonderland lies between the Sierra Shoshone and the Rocky Mountains, between latitude 44° and 45° north, its mean altitude being about 8,000 feet above the ocean. It has an area of 2,500 square miles, covering for the most part a very abrupt and broken country, abounding everywhere with impressive views of mountain scenery. The interior, however, is very beautiful, being diversified with rolling hills, dense forests of feathery top pines, open glades and park-like views, with now and then a miniature savanna of silvery lakes and rushing streams. The atmosphere is salubrious and transparent, imparting to the far off peaks a sharp outline and the appearance of close proximity. The greatest collection of natural curiosities in the world has been gathered by nature herself in this National Park, lying in Montana and Wyoming Territories.

The Yellowstone Lake, a handsome sheet of water, is situated in the southeast corner of the park, at an elevation of 7,788 feet above sea level. Along its southern and eastern shores the mountains present an impressive scene of rugged beauty, being very lofty and abrupt. This lake covers an area of over 300 square miles. Trout are found in great abundance near its outlet, but owing to the juxtaposition of subaqueous geysers they are not edible. Those caught, however, at the head of the lake, where the cold waters come rushing in in the shape of mountain torrents, are good. In the mud volcanoes we see another wonderful freak of nature. Down in these craters the hot mud can be seen thrown in many shapes. After sufficient steam has been generated, a huge mass is thrown several feet in the air, and, falling back into the crater, this action is repeated.

Prominent among the grand views of the Park are the falls of the Yellowstone, which afford a truly magnificent sight. The upper fall is 140 feet high, the grand falls are over 300 feet high, the foaming water rushing over the vertical falls, like a moving stream of snow. The mighty torrent, spanned by a rainbow, descends with a thundering roar that can be heard afar off. Below the falls the grand canyon begins, extending thence twenty miles down the river. The walls stand pependicularly nearly 2,000 feet high. The Mammoth spring, near the northern boundary of the Park is also a noted place, attracting many visitors by the medicinal properties of its waters. On Specimen Mountain some rare curiosities in the way of petrifactions are to be seen, some of them being standing trees, in the cavities of which some brilliant crystallizations are found; fine specimens of banded and clouded agates, opal, chalcedony, carnelian and other rare stones can be picked up *in situ* on this mountain. The National Park is destined to become the most famous watering resort of the world. Its mineral waters consist of great diversity, and is infinitesimal and replete. No tourist can ever regret a visit to the great wonderland, and for a few weeks consult nature's sanitary domain and witness her grand and unique sceneries.—*Mining and Scientific Press.*

THE WORLD IN WAX.

MR. GRUBE, a maker of wax images in this city, has constructed what is claimed to be the largest globe of the world, showing the ranges of mountains and other peculiarities of the surface of the earth in relief, now in existence. Its diameter is 4 feet and about 1 inch, the scale being 1 in 10,000,000. The range of even the Himalayas would not be visible upon this globe if the scale were adopted for the elevations as for the map, and accordingly the relief is made upon a scale which exaggerates heights twenty times. The oceans, seas, and rivers are colored blue; the continents are yellow; the glaciers, icebergs, and floating cakes of ice white. Plains and mountain ranges are clearly shown, and every part of the world is exhibited in its true character. Red, black, and white lines cross the globe to indicate the isothermal belts, the variations of the magnetic needle, the date line where ships correct their logs by skipping from Saturday to Monday, and *vice versa*, and other facts of like character. The map has been corrected in the light of the latest discoveries down to two months ago. The northern coast of Siberia has been much altered in the atlases by the Nordenskjöld expedition, the ships sailing in deep water over places marked as 500 miles inland, and being compelled to go hundreds of miles around promontories, etc., which are occupied on the maps by bodies of water. The globe is made of wood. The relief is formed by wax. Mr. Grube has been two years in perfecting his globe, and Chief Justice Daly and other geographers have lately been giving attention to it.

A BURIED FOREST.

IT has been recently discovered that an oak forest lies buried in the Valley of the Fulda, near Rosenburg, Hesse Cassel, Germany, at a depth of from six to nine feet below the surface. The wood flourished at a very remote period. The greater number of the trees discovered were in good preservation; but, owing to the action of the water through unnumbered ages, they have become thoroughly black in color; they have also become very hard and close, so that they would be good material for carving and ornamental cabinet work. Some of the trees are of great size; one taken out of a gravelly portion of the bed opposite the village of Baumbach, and since sent to the Geological Museum at Berlin, was 59 feet long, nearly 5 feet in diameter near the root, and about 38 inches at the top. Even larger specimens have been found. It is reported that the furniture and fittings of the Geological Museum at Marburg are to be made from this long buried timber. It is not yet decided whether these buried oaks belong to a species still existing or to an extinct one.

THE GREAT SPIRIT SPRINGS OF KANSAS.

THESE springs, located about three miles from Cawker, to the southeast, are great natural curiosities, and in the future will undoubtedly be a great place of resort. Approaching them from any direction you find paths pointing toward them, now nearly overgrown with grass, made by buffalo in going to them for salt, no doubt, when this now almost extinct animal roamed so extensively and supremely over this region. The spring, which is a general term for what is actually a mound, in the top and center of which is a basin of perfectly clear water, is about the most unexpected thing to find here that can be thought of. The mound is some sixty feet in diameter, twenty feet high, and almost circular in shape, with oval top. The water from the basin does not flow over the top now, although it may have done so in the past, but comes out on the south side in a clear little basin, where the drinking water is obtained. The basin on top of the mound is said to be very deep, almost fabulous, in fact, but, I am confident, highly exaggerated. Water oozes out on the sides of the mound in a few places only. A little dry ravine comes in on either side of the mound (I must say spring), making it an island, in fact, or it would be an island if there was any water in the ravine. There are many theories as to how the spring came to exist in this shape, one of which is that by continued overflow for hundreds of years, the water leaving a deposit of lime, gradually rose at the rim, and flowing over, caused the almost gradually sloping or circular sides. From my observation I am convinced that such is not the case, as the rock, of which the mound (spring) consists entirely, is in stratified form, each stratum being almost level and apparently running from side to side. The water has a brackish salty taste, much resembling in taste that from the Iola wells. It is said to have many curative principles, and has been used here to some extent by physicians.—*Cor. Kansas City Times.*

THE ANTIQUITY OF MAN.*

By REV. L. J. TEMPLIN.

THE doctrine that man had existed on the earth only about 6,000 years had been so long believed and so universally accepted that there seemed to be little or no disposition to call its truth in question. But this quiescence has been rudely startled by the announcement that recent research has brought to light human relics and fossils that demand for their explanation a lapse of time amounting, according to some, to tens of thousands, and, according to others, to hundreds of thousands of years. It is not the part of wise men either to accept or deny the truth of statements purporting to be based on facts without a careful examination of the facts in question. While the fact that a new theory or doctrine contravenes old-fashioned opinion is no justification for its hasty rejection, it is a good reason why all the facts in the case should be subjected to the crucial test of the most searching investigation. In approaching the subject of the duration of man on the earth, therefore, we should strive to divest ourselves, as far as possible, of all prejudice arising from education or association, and give to every fact bearing on the question a fair, candid, but critical examina-

* Read before the Popular Science Club of Hutchinson, Kansas, March 12, 1879.

tion, and accept the conclusions that fairly result, whether they accord with the notions we have previously entertained or not. An investigation of the subject, in the spirit I have indicated, will doubtless require a modification of those views that regard man's existence on the earth as not exceeding less than 6,000 years, allowed by the Usherian chronology, while those that hold a period of human existence amounting to many hundreds of centuries will have to abate much from their claim to so great an antiquity for the human race. While making this concession, I do not wish to be understood as detracting one iota from the divine authenticity and truth of the biblical record. What is commonly received as the "Bible chronology" is only man's uninspired inference from certain genealogies that we have reason to believe are not, and that probably were not intended to be, perfect. Our interpretation of these Scriptures may require revision to correspond with the facts of science as well as the true meaning of the record, as has been the case in other instances.

The evidences of the prehistoric existence of man in Europe and America consist of relics of various rude manufactures, such as rough pottery, stone implements, broken bones, and shell heaps; of rough drawings of extinct animals, and of human fossils, either in ancient geological strata or in connection with the remains of certain extinct animals. The human period is divided into three ages, designated by the kind of material used in the manufacture of weapons and implements, as the Stone, the Bronze, and the Iron ages. The Stone age is also divided into the Paleolithic, the Reindeer, and the Neolithic eras. The first of these indicates a time when the manufactured implements were rudely made of unpolished stone; in the last they were of polished stone, with other evidences of a more advanced state of civilization. The Reindeer era seems to have been a period when a second glacial condition drove the animals and people of Northern Europe southward, where many of them left their remains embedded in the sedimentary deposits of that time. Some of the oldest relics of man are found in certain peat-beds of Denmark. These vary in depth from ten to thirty feet. In these, at various depths, are found embedded the fallen trunks of different kinds of trees. At the greatest depths are found logs of the Scotch pine—*Pinus Silvestris*—a species that was extinct in that region at the beginning of the historical time. This was followed by a sessile variety of the common oak, and this by the common beech, the only one known in history to belong to that region. Beneath the logs of the Scotch pine, at the lower part of these bogs, certain stone implements have been found that seem to prove that man existed there at the time this timber flourished in that region. How long a time it would require for the growth and disappearance of these successive forests, and for the accumulation of these beds of peat, we have no means of knowing; but that a few thousand years would give all the time needed, appears highly probable, from the rate at which such changes are taking place at the present time.

Another class of memorials of man's early existence in Northern Europe is found in the "shell-heaps," kitchen middens," found along the shores of the various Danish islands. Some of these mounds are as much as 1,000 feet long, 200 feet wide, and 10 feet high. They are made up of the shells of oysters, cockle, and other mollusks, together with the bones of various existing animals, and of birds and fishes; and occasionally scattered through these are flint hatchets, knives, and other instruments of stone, bone, horn, and wood, with pieces of pottery, but no bronze nor iron.

Similar shell-mounds are found in the United States, from Maine to Florida, and in the Mississippi Valley, especially near Keokuk and Cedar Rapids, and on the Des Moines River, in Iowa. These consist of the refuse of such mollusks and other animals as are found in the adjacent waters. That these last are of ancient date, we have no satisfactory evidence; but that those of Europe reach back to a very remote antiquity, is inferred, from two facts: First, that these mounds are not found along the shores of the Western Ocean, where the waves are continually eating into and carrying away the land and burying it in the depths of the sea; where it is inferred shell-heaps were formed as where they are now found, but by the continual attrition of the waters they have disappeared. Second, the shells found in those heaps are thrice as large as the same species existing at the present time in the adjacent waters of the Baltic. From this fact it is inferred that at the time their contents were used as human food the ocean had a much freer access to the Baltic than at present, and that by elevation the oceanic waters have been so cut off that the fresh waters of rivers flowing into that sea so predominate as to stunt the growth of these animals and reduce them to one-third their original size.

Whether the facts warrant the conclusion of so high an antiquity as has been claimed is difficult to determine.

These mounds may have never existed on the shores where they do not now exist; or, if they did, four or five thousand years may have been sufficient for every vestige to have been swept into the sea.

The explanation given of the reduction in the size of the molluscan inhabitants may not be the correct one; a scarcity of food or degeneracy from some other cause may have produced the reduction in size. But if the cause assigned is the true one it does not necessarily prove an antiquity for the people whose feasts furnished the refuse for these heaps anything like so great as has sometimes been claimed. Of this I shall have something further to say hereafter, if space permits. Certain bones dating back to a period previous to the glacial epoch have been found bearing marks and scratches that have been thought to be the product of human hands. But on examination it was found that the same strata that contained these marked bones also held the fossil bones of certain carnivorous animals and fishes, whose teeth leave on the bones they gnaw just such marks as those under consideration. So Miocene and Pliocene man suddenly disappears. Various rudely-chipped bits of flint supposed to be intended to serve the purpose of hatchets, knives, spear-heads, etc., have been found at various places on the Somme and Seine rivers, in France, and also at Hoxne, in Suffolk, England. These are associated with the fossils of an extinct elephant, rhinoceros, lion, and cave hyena, besides those of some animals yet living. It has been supposed that the juxtaposition of the bones proves that man was contemporaneous with the other animals named. But there are many doubts about the nature, relations, and time of life of these flint chips. Some maintain that they are not of human workmanship at all, but only the result of the action of frost on the quartz rocks. Others admit their human origin, but claim there is no satisfactory evidence that human beings lived at the time the animals did. And, doubtless, great weight is to be given to the objections to the contemporaneousness of man with these extinct animals. The remains are found in the old bed of the river with every indication that they were deposited under the violent action of water, hence it is reasonable to suppose that the various relics have been washed from entirely different strata, and, after being mingled together, have been deposited in one common grave.

But while there are reasons for believing that the flint implements of Abbeville, Amiens, and other places fail to furnish evidence of the contemporary existence of man and extinct animals, in other cases there is no room for doubt of this fact, as, in some instances, the remains of man are so related to those of extinct animals as to preclude the possibility of doubt that these animals lived in Europe contemporary with man. This is proven in the case of the Menton man whose skeleton was not only surrounded, but covered many feet with the remains of the cave bear, cave lion, cave hyena, and others. Without pursuing these particulars further, I may sum up my conclusions, from a careful examination of the various facts bearing on the question, as amounting to a conviction that man came in at the close of the glacial epoch; that he witnessed the retreat of the glaciers from Central Europe; that he has seen the Scandinavian peninsula and the British Isles united by solid land to the continent of Europe with the Thames as a tributary to the Rhine; that he has seen the elephant, the mammoth, and many other now extinct animals in their native haunts in Europe; and finally, that Mongoloid man crossed from Asia to America on an isthmus in the place now occupied by Behring's Straits. I am aware that such announcements naturally bring up the idea of vast geological time, of which fifty or even a hundred thousand years would prove an entirely inadequate measure. We think of these events as belonging to the dim past, beyond the reach of our ordinary methods of computing time. But have we not assumed this vast distance of time rather than proved it? Have we not mistaken darkness for distance, and assumed that our ignorance on this subject was really knowledge? Because vast geological changes have taken place since the Champlain epoch was ushered in, it has been inferred that a time of immense duration has elapsed since the retreat of the ice of the Glacial Epoch from Southern and Central Europe. But aside from the images of men, what evidence have we of this vast time? The reign of ice has not entirely ceased in our own day.

The ice fields that the Stonefolks saw, perhaps on the Rhine, we witness in Siberia, Northern Russia, and Greenland. The glaciers still linger amid the peaks and higher valleys of the Alps and neighboring ranges. In our own country their retreating footsteps are still seen among the gulches of the Sierra Nevada and the Rocky Mountain ranges, and their buried remains are still found in huge masses of ice in the ice wells of Vermont, New York, and Wisconsin. With these evidences before us is it unreasonable to suppose that a few thousand years has been sufficient for the removal of these fields of ice from the low lands of Central Europe to their present localities? The same, I think, may be affirmed of the geological changes that seem to have taken place since man's advent in Europe. It will not do to relegate all these to the distant past, for we are living in the midst of these changes, many of which are slow and uniform, while others are catastrophic in their nature. Many gradual elevations and depressions of special localities are going on during our own age. Southern Italy has been subject to vertical oscillations of twenty feet or more within historic times. The Andes have been depressed 220 feet in the last three-fourths of a century. The northern part of Sweden is undergoing gradual elevation. Many changes of this nature are now going on at various localities along the eastern coast of North America. More sudden changes, that produce greater changes in a few hours than the above noticed will in as many centuries, have occurred in quite recent times. We have seen the whole coast of South America lifted up ten or fifteen feet and let down again in an hour. During an earthquake in 1819, 2,000 square miles in Southern Asia sank and became an inland sea, while adjacent to it a belt of country fifty miles long and in places ten broad was lifted up ten feet above its former level. With regard to the coast on the Baltic, we have evidence of a very important depression since the existence of man. While digging a canal near Stockholm the workmen came upon a fishing hut at a depth of sixty feet. And as this subsidence is still going on, it seems to stand in corroboration of the theory that at no very distant day, as compared with the lapse of time claimed by some, that region stood many feet higher than at present.

Having shown that the geological changes that appear to have occurred since man's advent into the world do not necessarily require such a remote antiquity for their explanation as some have supposed, we next inquire what evidence is furnished of the great antiquity of the human race by this coexistence of man with extinct races of animals. Until quite recently no evidence existed that man was coeval with any of these extinct races, and it was therefore assumed that they were of very high antiquity; and when it was found that the remains of man and extinct animals existed in such juxtaposition as to prove their contemporaneousness, instead of exciting suspicion that an error had been committed in assigning so high an antiquity to these extinct animals, it was thought to be necessary to carry man back to the remote ages when they are supposed to have lived. But wherefore? Why carry man back instead of bringing the animals forward? There is no necessary reason for assigning animals to a distant antiquity simply because they are now extinct. We are witnessing the extinction of species at the present time. The Maories of New Zealand retain traditions of the extinct birds of their islands. The Dodo, of Madagascar, now extinct, was alive 250 years ago. The Solitaire and Æpyornis have become extinct in modern times, as also the whale, once so abundant in the Bay of Biscay. The great Auk, of Newfoundland, and the Labrador duck, seem to have disappeared within a few years past. The American bison, that but a decade of years ago grazed in countless herds over these plains, and even on the spot where this flourishing city now stands, is rapidly approaching extinction, and unless the government speedily inaugurates some efficient measures for its protection, this noble beast will soon have disappeared from the face of the earth. Now if, as these facts prove, races of animals are becoming extinct during our own times, the fact that human fossils are found buried in the grave with many extinct animals of Europe, may just as readily, and with as much show of reason, be explained on the supposition that these animals existed at a comparatively recent period of time, as on the countersupposition that man existed in the remote ages that have been held by some. The facts in the case do not seem to demand for their explanation a lapse of time so great as to do any great violence to the opinion that has so long obtained on this subject.

An argument much insisted on in favor of the great antiquity of the human race is drawn from the fact that Egyptian monuments prove that about as great divergence between the races had been reached 3,000 or 4,000 years ago as are found to exist at the present day. It is held that if the 4,000 years that have elapsed since the pictures of the different races were drawn on the walls of Egyptian temples have produced so ilttle perceptible change as we see, it would require an incalculable number of years to produce the differences that we find existed at the time. This has led many eminent men to the conclusion that the different races are distinct species, and as such have originated at different times and places. But a law is now coming into very general notice that is capable of explaining the great differentiations that have taken place without demanding so great a duration of time. It is "that species when first introduced have an innate power of expansion, which enables them to rapidly extend themselves to the limits of their geographical range, and also to reach the limits of their divergence into races." Under the operation of this law, when a new type of animal is introduced, it is speedily differentiated into the most diverse forms and characteristics of which it is capable, after which these divergent forms or races will run along in a parallel existence until, by unfavorable changes in the environments, they one by one drop out and become extinct.

Numerous illustrations and proofs of this law might be cited from the fossil history of the past, but lack of space forbids it here. Under the operation of this law, man, when first created, would speedily reach the limits of his capacity for divergence into races; and after having reached these limits the resultant races would continue a parallel existence to indefinite time. Supposing the sons of Noah to have been subject to this law, with possibly this tendency to divergence in a particular direction in a case of each, intensified by inherited peculiarities in their wives, and we have all the conditions essential to the production of all the race differences that are shown by the most ancient of Egyptian records, even assuming that the human family has existed but 6,000 or 7,000 years. There appears to be no necessity for the immense lapse of time that some have felt called upon to assume to explain the differences that exist in the races of mankind.

A similar argument to that based on the existence of different races of men has been drawn from the great diversity of languages that is found among men. Thus it has been assumed that languages have been formulated in the order of their complexity of structure. According to this theory, the great families of language have appeared in the following order: 1st, the Chinese; 2d, the oldest Turanian formation, or Thibetan; 2d, Hamism, the language development of ancient Egypt; 4th, Semism; 5th, the highly perfected and harmonious organisms of language, or Arism. Such is supposed to be the order of evolution in language, resulting in the symmetrical and highly specialized organisms found in the Arabic, Sanscrit, Greek, and Latin. Assuming the above to have been the order of development from the simple monosyllabic language of China to the highly complete forms of the Aryan languages, and assuming, further, that the slow changes that are taking place in living languages are a fair measure of the rapidity with which such changes proceeded in the earlier history of languages, the deduction is arrived at that the time essential to the evolution of these highly complete forms of language is to be recorded not by thousands, nor even by tens of thousands, but by hundreds of thousands, if not millions, of years.

But is such a corollary a necessary deduction from the facts in the case? What evidence have we that these languages have followed each other in the order of increasing complexity as antecedent and consequent, or rather as parent and offspring? The declaration is a bare assumption, not only destitute of affirmative proof, but also antagonized by numerous facts bearing on the question. As a matter of fact, we find all these varieties of language existing coetaneously at the present time. Living representatives of all these great linguistic families may be still found in existence. Nor does history show that any of these great families of language ever sustained the relation of parent or offspring to any other. What we find to be contemporary, and to have been so throughout historic time, we are under no obligation to believe were ever consecutive. Several modes of linguistic progress may have run their course contemporaneously in the world, their characteristic differences being due to the peculiar genius of the different races of men. The theory that language has grown up by development and accretion from the most simple articulate expressions of emotion, may be the only method that science can take cognizance of, yet it may be true, nevertheless, that, instead of being the result of this painful and slow process of development, language was at first received by direct communication from a source of superhuman knowledge. In any case we do not find in the present structure, nor in the past history of language, anything to warrant the assumption of a very remote antiquity of the human race. We have no standard by which we can measure the rate of development or differentiation of a language during its early history; hence all conclusions drawn from such speculations are fallacious and unreliable.

I have now passed over the ground covered by the discussion of this question, and have given my reasons for the opinions expressed in the beginning of this paper, viz.: That the existence of man on the earth probably extended farther back into past time than the limit assigned in the most popular chronology of the present day; but that the claim for the human race of an existence reaching back through many decades of centuries seems to be based upon erroneous interpretation of facts, and hence to be destitute of adequate support of proof.

In conclusion, I may say that there is so wide a difference of opinion among savants, both as to the facts and their interpretation, that it is quite too early to announce any positive conclusion upon the subject, and the honest inquirer after truth may well hold his judgment in reserve and wait for further development of facts.

THE CUNEIFORM INSCRIPTION AT NINEVEH.

"ONE of the principal objects kept in view during these new excavations," says Mr. Grattan Geary in speaking of the excavations now making at the site of Nineveh by Mr. Hormuzd Rassam, "is the recovery of the remainder of the historical and legendary tablets which were deposited in the royal libraries. The completion of the series giving the Isdubar legends, amongst which the account of the Deluge is the most remarkable, is above all things desired. The tablet giving the portion of the legend relating to the Deluge, which was first deciphered by the late Mr. George Smith, was discovered by Mr. Rassam; and therefore there is special fitness in his being intrusted with the task of completing the search subsequently begun by Mr. Smith for the tablets still required to complete the se-

ries. He was so far successful in his operations that he had, within a few months of my arrival, discovered nearly fifteen hundred tablets, or portions of tablets, bearing cuneiform inscriptions. Additional parts of the Isdubar legends are amongst them, as well as lists of gods, many prayers and invocations, and other matters throwing light upon the religion of the Assyrians. Not the least valuable of the cuneiform records found would have been lost forever, but for the steady observance of the rule that nothing, however unpromising, was to be passed over.

In excavating in the royal library of the palace of Sardanapalus—or Assurbanipal—a piece of wall, four or five feet high and eight or ten long, composed of sun-dried brick, stood exposed. All the debris around it had been removed and sifted, and nothing more was looked for. It was proposed to throw the rubbish from a new part of the cutting in the cleared space, and cover up the bit of useless wall. But Mr. Rassam directed that the wall should be first knocked down. In removing it the men came upon a literary treasure, equal in importance to any yet recovered from the whole site. Built into the wall, and as it were embedded in the sun-dried bricks, was a large decagonal terra-cotta cylinder, some twenty-two inches long and two feet in circumference. Its sides are closely covered with very small cuneiform characters, in ten columns, exactly like those of a modern newspaper. There are 1,275 lines in all, containing an elaborate account of twenty years of the rein of Assurbanipal, and all his wars against Egypt. The columns are nearly the width of those of an average daily newspaper, and rather more than half their length. The subject is divided into sections by what a printer would call 'rules' across the columns. Some sections occupy half a column, others a column and a half. We may expect great things from the translation of this most elaborate chronicle. It dates from the year 640 B. C."

ROB: A BIRD BIOGRAPHY.

By REV. SAMUEL LOCKWOOD, PH.D.

IN the clearer light of these latter days, a higher value has settled on the so-called small things of nature. To-day the student thinks he finds in the lower realms of animate beings a psychology, perhaps also a morality, and a self-consciousness, which he asserts are the "baby figures" of better things that were ordained to come. It may be that Mrs. Partington spoke wiser than she knew when she said; "Human nature is human nature, if you do find it in a cow." And though so lowly, how educable are these emotional and sensitive creatures! Could one know all about them, perhaps each would be found to have an interesting biography. Let us attempt to tell the story of a tame robin, *Turdus migratorius*.

Rob, for so we shall call him, was taken from a nest on Long Island. Though passed the callow stage, he was not fairly fledged. His pap was meal mixed with fresh milk, a point which he insisted on ever after. He was turned a year old when he became one of our pets, and very soon he had established himself in our affections. He was very exacting of attention—so demonstrative and familiar. In the very pertness of its humor the conduct of the bird seemed paradoxical; for though in its way almost beseeching your notice, it would, on your approach, assume a repellent attitude, with wings striking and bill snapping. But to witness the "high jinks" of his fury, it was only necessary to intrude a hand into the cage, keeping the back upwards, and Rob would seem wild with savage gladness, for he would settle on it and peck away with his sharp bill at the knuckles as if he were picking into a big bonanza. Much sentiment is wasted about keeping birds in confinement. Does it not generally come from such as are intolerant of pets? "It is a deprivation of natural freedom." So thought the horse in the meadow, as he beheld the ass roaming in the unfenced sand lots. Even birds may have "hard times." Yes, I have known the wild birds to be starved to death within the sound of a canary's song. But perhaps Rob was unsentimental, for it was plain that prison or not he liked his cage In it he was at home, and well to do—away from it he was adrift and unsettled. The door of the cage was sometimes left open for a little while, a proceeding which usually called for large consideration on the part of the occupant. At such times he would look as quizzical as a knowing young barrister: "Want to get me out, hey? Ah, but possession is nine-tenths of the law!" Still, even wise folks may be inquisitive, and Rob was not above that weakness. He would stand on the door sill of the cage and with those pretty hazel eyes take in the outlook. This done, with a gravity fitting the act he would step in again, and resume his uppermost seat—the top perch. Sometimes Rob would come out for a little while.

As a rule, excess of freedom is pretty sure to cause our pets to come to grief. The real giant grim of the birdies is Grimalkin; and he is everywhere. We had got lengthening Rob's parole with bad effect on his circumspection. In fact there was a slacking up of the usual bird prudence. One day found him missing. So Rob had run his parole! No, he had not. The pear tree was white with bloom, and he thought to enjoy its branches. Alas, Grimalkin was hidden there, and the catastrophe was serious. We found the poor bird half dead, with a gory laceration of the breast. How he got himself out of the mouth of the carnivore seemed a mystery. But Rob had gone through life so far on his cheek, and my belief is that his escape was due to his plucky impudence. In this case the proverb had been emphatically true. "Familiarity breeds contempt." I had often taken him pettingly into my hands, when, not from terror but sheer temper, he would bite and scream like a vixen. He seemed to fear nothing. As for the cat and dog they were nobodies whom he saw every day. Now, I have seen the wild robin when caught by the cat, and the victim was as resistless as a clod, in sooth, it was paralyzed with terror. With Rob the case, I think, stood thus: The cat had a hold on his breast with her mouth, but owing to the smallness of the branch which supported her, she had to use all her feet to keep her position, although needing the fore one to help retain her prey, for Rob, though badly frightened, kept his senses, and doubtless used his wings and bill to good purpose on the face and eyes of his grim captor, thus accomplishing his release. It was a long while before the bird got over that wound, which left an ugly though not dishonorable scar.

The bird had its own amusements. Is there not an instinct in whose manifestations our little girls are strangely like the birds? In their plays how our children anticipate the cares and ways of motherhood—the nursing and the dressing of the doll, the make believe keeping house, etc. A hundred times have I seen cage birds go through a dumb show of mimic nesting, fussing with laborious concern over a feather, or stick, or straw, or hair. I have seen Rob running about his cage with a bit of straw in his mouth, and uttering a conceity twitter, as if he were in live earnest, and saying to a supposable partner in the business. "Here, Mrs. Rob, is just the thing you want."

If one wanted to get Rob on a string, it was enough to give him, in technical parlance, the proximal end of a bit of grocer's cord, reserving to one's self a hold on the distal end. How perseveringly the bird would draw the cord into the cage, and with system too. Seizing it with its bill an inch or two would be drawn in, and a foot put on it, then a little more pulled in and held in place in like manner, and so on until the other end was reached. Now the fun began. Gently the coil was drawn from under the bird's foot; this would bother Rob, for though he was pretty fair on practical reasoning, he could not take a step in the abstract. With quickened energy he would go the thing all over again; and again he would find his labor slipping from under his feet. This at last would excite a spurt of temper, and the thing would be given up in disgust.

Owners of cage pets do not always reflect that birds of the Passerine group are the most delicately organized; hence they are often irritable. Coues has well called them fast livers, they so freely consume oxygen. Rob had a high temper. A trick, perhaps unwise but really amusing, was sometimes played on the bird. A bit of rubber or elastic cord was tied to one of the wires of the cage. Rob would seize it in his bill and pull; though but an inch long, the bird's efforts would stretch it to a number of inches, when just as he was pulling the hardest, it would fly back again, and Rob, to his dismay, would be set back too, with a recoil that fairly lifted him off his legs, and over his tail backward. In the matter of experience the bird never learned at the first lesson, but would keep on meeting the same mishaps, until badly beaten with his own petard, we would give it up as a bad job.

There may not be much dignity in it, but the boys do find some enjoyment in running backwards and forwards by a picket fence, teasing the testy dog which keeps up with him on the other side. Often Rob had his disposition tried by some one rasping a finger along the wires of the cage. He would pursue the obnoxious digit, snapping his bill furiously, as only a bird can do. By and by would be heard a sharp involuntary "Oh!" telling that Rob had got in a good point on his tormentor, and thus closed the game.

Our robin often afforded matter for study and delight in those expressive attitudes of which birds only are capable, and which too effectually elude the artist's pencil. What high wrought excitability and poetic expression appear in these movements. What barbaric defiance in the cresting of the crown feathers of the head, that queer furring up, or puffiness of the cheeks, indicating that the bearing is keyed to a strain; that jaunty setting of the head, and saucy cocking of the eye, for a bird never looks so knowing as when he looks sidewise—all this fills a hiatus where speech cannot get in. Even the tail adds to the action. Now comes a decisive chirp. A conclusion has been reached in the bird mind. Next is a series of rapid chirps, making a whirr of sound. This is the call note of his tribe, for he has detected a turdite in yonder grove, and hark! the call is answered.

But what does Rob know of his clan? Well, some knowledge he has of inheritance, for there is both with birds and men a knowledge which cometh not with observation; some of their ways have come to him by descent. It is now March, and Rob has the spring fever badly, that migratory frenzy which has set the whole tribe moving north. While the spell lasts he is impatient of home, and is as mad as a March hare. Some robins in that cherry tree have set him fairly wild; and even when there is neither sight nor sound of bird, that migratory impulse, that mystic call to move and mate, keeps the poor bird uneasy. Happily it does not last many days. By April he does something better than chirp, for he gets into a strain like the conjugal song of the robins. Through several days it is so low, soft, and silvery, so tender and sweet; but this over the melody is set on a higher key, and becomes a volume of exultant rapture. He has now taken up an octave flute. In his dumpy moods he has been talked to pettingly so much, that he knows the words like a book: "Wake up, pretty boy! Wake up! Wake up!" The boys sing the words, again, again. Then they whistle them. The bird catches this little snatch of melody, and executes it in a clear distinct enunciation. This is Rob's best role. Pity that sweetness should ever clog, but Rob did give us too much of a good thing. Through the summer months, an hour before daylight, on the highest key possible, came that piccolo strain, "Wake up, pretty boy! Wake up!" Bob's cage was inside the window blinds, and by the time the twilight was breaking up, generally several robins had visited the cherry tree near the house, attracted by the singer whom they could not see.

The prince of the mimics is the mocking-bird. But to some degree are not all the thrushes mimics? The cat-bird is really clever in this direction. However, I own to a surprise on hearing that Rob had gone into the mimic art. Whenever our black-and-tan, Dick, heard his young master whistle an invitation to take a walk with him, the affectionate brute would almost lose his head in yelping gladness. It was a beautiful day in June, and Dick was seen acting as if half dazed, running up and down the yard looking for his master, but unable to find him. Rob had learned the dog-call, and from behind the window blinds was practicing his new accomplishment. The dog soon saw the trick and slunk away not a little abashed. We all felt that though funny, it was really mean of Rob. Our neighbor's fine hunter was bothered in the same way. Rob tried his hand on the call used by Madame to her poultry at feeding time. The attempt did him no credit, perhaps for the reason alleged by one of my sons, that "the chickens didn't know enough to get sold." But with some folks failures are simply the preludes to success. Our mimic had grander things in reserve

Rob's successful play upon Dick was not his only attempt at imposition On one occasion the good lady of the house being up stairs came running down in great concern, there was such a cry of distress among the young chickens. "Peep! peep! peep!" in rapid plaint smote her gentle ear. To reach them she had to pass Rob's cage. Here she stopped short, and gave vent to an outburst of laughing indignation, for it was Rob, the rascally mocker, who was doing his best to set all the maternal hens at ears about their babies. Though somewhat perplexed, these elderly birds were not very badly taken in. At another effort Rob achieved a marked success; he imitated the cry of the mother-hen when the hawk is overheard—that low whirring note of danger. All was consternation in the barn-yard. Away sped each callow brood to their own particular mamma, who, unable to see any danger in the air, yet supposing the alarm to come from some watchful mother that did, instantly took her own charge under her wings. Rob's mimicries were generally perfect. In executing some of them he was so loud voiced as to be heard a long way off. Persons at quite a distance have been attracted by these notes, and have called to see our "mocking bird," and been much surprised to learn that it was "only a robin."

The senses of birds must be very acute. I would instance in Rob's case that of scent. He was extravagantly fond of fresh beef, and though in a different room, could tell the arrival of the butcher's boy in the kitchen, when he would scream with impatience. Little strips of raw beef were fed him. If when receiving one morsel he saw another in the fingers of his mistress, he would drop it on the floor of his cage and wait for the next bit with nervous impatience; and so would he do until he had secured all that his sharp eye saw, which done, he ate these delicacies in a perfectly orderly way. How unlike a dog which swallows as fast as he can the meat given it. But Rob was particular, the meat so providently put on the floor of his cage was thus rendered dirty; the knowing bird would take it piece by piece and wash it in his water tub. This conduct showed the nearest approach to abstract reasoning that I ever saw the bird make. Many of the birds like this condiment of leisure with their food. How often have I seen a fowl pick up a grain of corn, then drop it and look at it, then pick it up, drop and inspect again several times, then swallow it, and all with no other logic in the matter that I could see, than to make the most of one's blessings. So with Rob, having got his store before him, he enjoyed it in a leisurely and sensible way. He was very fond of the larvæ which we used to find in chestnuts. Even these he could smell far off, and would go into ecstasies, making a lively chattering talk as one was brought to his cage. The presentation of a spider was a grand event. But as to earth worms, he had a soul above all such. So far as Rob was concerned, the early bird was entirely welcome to them.

I think our pet must have been five years old when he had a hard time moulting, and the result, too, was quite notable. When the large feathers began to come, two white ones appeared in the tail. Oh, tell it not among his kith that Rob, the plucky and the impudent, shows the white feather! But leaving figure and coming to fact, the truth is, the poor bird was greatly distressed about it, so much so that he made up his mind he would not stand it, but would extract the offensive things, and at it he went. The tail was deflected so as to meet the head, itself turned under the perch; the bill then seized one of the craven feathers and pulled desperately. As if the perch were a trapeze, the bird swung fairly round, going over backwards and falling on the floor of the cage. But the feather had not come out. At it again he went in the same way, and with the same result. And this was kept up nearly an hour, by which time the tail had become all dyed with blood. At last the odious feathers were removed, and the poor bird, weak, bleeding, and suffering, put its head under a wing and took rest. What shall be said to this? Was it pride, a certain proper self-respect? We cannot say. But this matter caused us a good deal of solicitude, for it was kept up some weeks, as the feathers would come in white. So at length the bird submitted in sheer despair. When the feathers came to the full there were two white ones in the tail, and as many in each wing. At the next moult the number of white feathers increased. When he was eight years old the primaries of both wings were of a snowy whiteness, also the retrices, or large tail feathers, except the central pair which kept their normal dark color in bold contrast as lying on a bed of white. This certainly was a strange costume for a robin; in good sooth, his own mother would never have known him. In our eyes Rob, though in an eccentric costume, seemed a gay and elegant fellow.

This partial albinism, we believe, is occasionally found among the robins. But what is its meaning? Attacking the largest feathers of the tail and wings, it might indicate inability of the pigment cell to furnish color any longer at those parts of the plumage where the demand was the greatest. It is doubtless due to an exceptional atrophy of the secreting color glands.

Our pets were usually divided round in the family. Rob was claimed by my daughter. It was a tender parting when with her husband she left for a new home in a great western city. And even Rob had no small share of our good-bies when taken to the car with the bridal pair. In his western home he was allowed enlarged freedom, his cage with open door being often set in the garden. When his cage was hung under a tree by the sidewalk, the pedestrians would stop and wonder what bird that could be with so strange a plumage and so novel a song. When free in the garden Rob would have a good time of it, occasionally finding a dainty insect. But the dear fellow was getting old. Nine years is rather high for *Turdus migratorius*, and his appetite was becoming a little unnatural. He found a piece of twine, and by persevering succeeded in swallowing it. That was the worst string ever Rob got on. That western investment was the death of him.—*American Naturalist.*

COLOR SENSATION.

AT a recent meeting of the Edinburgh Photographic Society Mr. Robt. Bow, C.E., F.R.S.E., delivered a lecture on the theory of color sensation, illustrated by diagrams and numerous interesting experiments. The lecture embraced Mr. Bow's latest researches and discoveries in relation to the subject, which, for many years past he has made his peculiar study. He (Mr. Bow) recapitulated some of the more interesting points of two lectures he gave before the Society in the year 1870, on the theories of color sensation, and on theories of color decoration, and gave some of the leading proofs of the correctness of the views, first announced by Wollaston and Young, that the simple sensations of color were red, green, and violet-blue. He noted that there had been some slight difference of opinion held by the followers of Wollaston, Herschel, and Helmholtz, naming the most refrangible color "blue," while Wollaston, Young, and Clerk-Maxwell named it "violet." He adduced reasons for believing that the correct color was between these two, viz., a violet blue, such as given in appearance by a moderate thickness of deep colored solution of ammonio-sulphate of copper. His chief argument was this—that the pure colors are not seen with a highly illuminated spectrum; the color near H, under intense illumination, becomes of a sickly, faded, pinky-purple character, and the blues and yellows are unduly developed, arising from the principle that no one color sensation can be intensely excited without sympathetically exciting at the same time the other two, and usually one more so than the other; thus in the Wollastonian spectrum given by the light from the sky and a medium width of aperture we have red, a narrow strip of orange-yellow, then the blue and violet; but as the aperture is gradully reduced the blue and violet become more violet from reduced excitement of the green seeing nerves, while the violet be-

comes bluer from the reduced sympathetic excitement of the red-seeing nerves, so that, eventually, the color above the green becomes uniformly violet-blue. Another original argument which he (Mr. Bow) advanced was this:

The length of the whole visible spectrum is dependent upon the degree of illumination, and becomes greatly contracted on making a great reduction in the supply of light. Now, if there be truth in the theory that the colors are due to three irregularly superimposed spectra, each spectrum should undergo contraction independently when the illumination is reduced; and this is really the case. Thus, the lighter blue first disappears, from the contraction apart of the violet-blue and green; and then on a very great reduction of the light being made, the yellow band itself becomes dulled. He had attempted to register the centers to which these contractions tend, and gave, as rough approximations, for red, C ·32 D; for green, D ·80 E; and for violet-blue, F ·37 G, on the ordinary prismatic spectrum—corresponding with Angstrom wave lengths of about 6,000, 5,375, and 4,610 respectively; but the last determination is not so trustworthy as those for red and green. As is well known, when the light is very greatly reduced the red seeing nerves, compared with the others, become much less excited; and so when the reduction of the light is made very extreme no red is embraced in the spectrum. It may, for instance, begin at D ·38 E and rise to above F ·54 G, showing a feeble green below a point about E ·81 F, and a feeble violet above the same.

The President, in a few appropriate remarks regarding the importance of the subject selected by Mr. Bow, invited Mr. Norman Macbeth, A.R.S.A., to express his views as to the practical value of Mr. Bow's investigation.

CONCRETE WALLS.

MANY farmers who desire to build good stables are deterred from doing so because they think it necessary to build a new barn for that purpose; and in order to have a proper basement stable they seem to regard a side hill as indispensable. Now, both these ideas are often mistaken. First, if the old barn is large enough and of the right form to suit the purpose, it may be raised and a good concrete wall placed under it, so as to give as good a stable as if under a new barn. When the wall is to be laid with stone by a mason, in the ordinary way, the shores or blockings are very much in the way of building the wall—requiring each blocking to be filled in after its removal, thus making much more work. But where the wall is built with concrete the matter is very easy. Raise the barn to the height desired (giving 8 feet in the clear for a stable); level it accurately on the blockings; then place 3x4 scantlings plumb under the center of the sills (not in the way of any window or door), in sufficient number to hold the building firmly in position; brace these from the top and take out the blockings. Now, there is nothing in the way of the concrete wall, as it is built around these shores, which will stand in the center of the wall, and cannot injure it by rotting. The wall should be 12 inches thick, and to build it set standards 15 inches apart, in pairs, so that 1½ inch planks, placed between them against each standard, will leave 12 inches between the planks. The pairs of standards will be plumbed, so as to bring the outside of the wall even with the outside edge of the sill. These standards and planks are carried around the building. Only one tier of planks is required, and it is convenient to have these 14 inches wide. When this box is filled with concrete, it will usually set hard enough while filling, so that the workmen may commence at the length first filled and raise it 12 inches, leaving two inches lapped on the first tier of the wall made, and each length of plank is raised in turn and refilled with concrete—thus placed layer on layer until the wall is completed. When the last layer is to be placed under the sill, raise the outside plank to the top so the concrete can be pushed against it, and the inside plank may be left down enough to give room for the introduction of the mortar. It can be tamped in solid under the sill, so as to make a complete wall with no space left for air.

The door frames are made of planks, with jambs as wide as the wall is thick. The door frames are set up before the boxings are placed, and box planks slide up on the edges of the door jambs. The window frames are set up under the sill, and the concrete fills up under and around them; and the basement should be well lighted. It is bad economy to save glass at the expense of liberal light in a stable. Sun light is as important to animals as to vegetables.

MAKING THE CONCRETE.

The concrete is made in the following manner: Take good water lime, mix one part lime with four parts sand before wetting it—mix thoroughly. If then you have coarse gravel, you may mix four parts of this; now mix this into thin mortar, and if you have cobble-stones, after placing some two inches of the mortar in the bottom of the boxes, bed all the stone you can in it; then cover with mortar, and chink in all the stone you can, till the box is filled. In this way you will get in about twelve parts of sand, gravel, and stone to one of lime. The lime is only valuable for cement—this cements the particles of sand together, and the sand and lime coats the gravel and fills the interstices between them, while the whole surrounds and coats the cobble-stones, and thus this one-twelfth of lime cements the whole wall together, which, on drying, becomes very hard, and, as will be seen, must be air tight. Very few walls laid in the ordinary way by masons will be found air-tight, an important consideration in a warm stable. The concrete wall renders a basement drier than a stone wall, because the concrete is a poorer conductor than stone, and therefore neither heat, cold, nor moisture can penetrate it much. After the wall gets dry, you never find moisture on the inside as on a stone wall of the same thickness. It is thus better adapted to inclosing basement stables than stone. The only precaution required is to prevent the soft earth from coming against it till thoroughly dry. Something should be placed against the wall, such as cobble-stone or poles, for the earth to come against, leaving a free passage for the circulation of air next the wall. The basement should not be sunk much in the earth except at the drive-ways on two sides, as it is not conducive to the health of animals.

BUILDING THE DRIVE-WAYS.

The general impression seems to be that a side hill is necessary to make a proper drive-way into the story above the basement, but this is an error. A small elevation is convenient, but a slight descent, such as will allow draining 18 inches deep, will afford abundant opportunities for building the drive-ways.

Suppose the barn be 40 by 50 feet, and the floor above the basement be across the barn, and the embankment for the drive-way to be 16 feet wide at the top, the 18 inches of earth to be had around the barn will raise both drive-ways 6½ feet, the basement being 8 feet high. The top of the drive-ways should always be graveled, so as to make the entrance to the barn dry and hard, that a full load may be drawn in. The labor of scraping the earth from the other sides of the barn upon the drive-ways is usually much over-estimated. A week's time, with man, team, plow, and scraper, will do the work most completely. Such a basement is not expensive. Under a barn 40 by 50 feet, the walls, doors, windows, and drive-ways would not in most places cost more than $175. This would furnish an excellent stable for 30 head of cows or other cattle, which would be only a cost of $5.84 per head, and this would be saved, in one cold winter, in the food required to feed stock. I thought these views would be timely in May, possibly inducing some to undertake it before haying and harvesting.—*E. W. S., in Country Gentleman.*

ARTIFICIAL SANDSTONE.

Glaser's Annalen contains a description of an improved method and apparatus for the manufacture of artificial sandstone. A thorough mixture of four to six parts of fine sand and one part of slaked lime is exposed for about three days to a high temperature and a pressure of more than three atmospheres, causing the formation of a silicate of lime which acts as a cement, so that the mass, when cooled down to the ordinary temperature, hardens. This hardening process continues for some weeks by exposure to the air, so that finally a product is obtained which is as hard and solid as good sandstone. The apparatus consists of a tank, into which the mixture is filled, and in which it is heated and stirred by a steam pipe, provided with a number of arms and rotated by belting or gearing. After the mixture has reached the proper temperature the steam is cut off, and a second vessel, inclosing the tank on all sides, is put into communication with the boiler. By this means the mass is heated for the period necessary. It is then run into a brick machine and shaped into the forms required. The process, it is claimed, effects great economy, especially for the manufacture of window sills, etc. The apparatus used is made large enough to produce 250 cubic feet of material in every charge—requiring, generally, three to four days.

ORANGE RIVER BRIDGES.

WE give above a perspective view of a bridge which has lately been erected over the Orange River, at Bethalie, Cape of Good Hope. This is one of four bridges of similar construction designed for carrying road traffic across the Orange River, the most direct route for the diamond fields. Passing through Bethalie it was necessary to commence this bridge first, as during the wet season all traffic, which is then the greatest, had to be carried across the river in pontoons dragged over by hand with a wire rope. During flood time the pontoons were useless, as the ropes gave way. The necessary money having been voted by the Cape Parliament the bridges were soon sent out from England.

The difference in the height of the river from low water mark to highest flood mark is 43 ft., but that is exceptional; the average depth in the dry season being 1 ft., and in the wet season from 15 ft. to 20 ft. The site of this bridge is on a reef of rocks of hard sandstone, situated at the top of a rapid, the speed of the river being about five miles per hour.

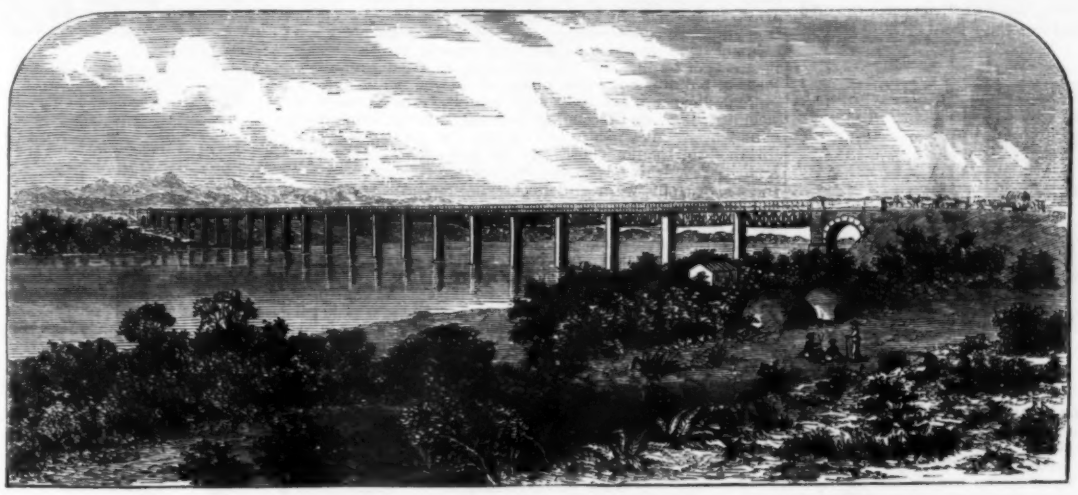
The contractors for the manufacture of the ironwork of this bridge and also for the bridge at Aliwal North, a counterpart of the Bethalie Bridge, were the Crumlin Viaduct Works Company, Limited, who also undertook the erection of the same; this, however, was transferred to the Cape Public Works Department, who completed the bridge, the engineers in charge of the erection being Messrs. Grier and Hyslop; the engineer for the Crown agents in this country being Mr. George Berkley, who superintended the manufacture.

The total length of this structure exclusive of approaches is 500 yards, the weight of ironwork being 1,000 tons. The bridge consists of twenty-two spans of lattice pin girders, supported by twenty-one wrought-iron cylinders, 10 ft. by 5 ft., of oval form, and filled with concrete, placed 63 ft. apart center from center. The foundations of these cylinders are carried down to a depth of 7 ft. in the rock of the reef on which the bridge is built. The clear width of roadway is 16 feet, a strong and suitable wrought-iron handrail being on each side. The girders are fixed 9 ft. apart, center to center, the roadway being on top is widened out by cantilevers, and is carried by wrought-iron curved plates riveted to cross girders. Each end of the bridge is completed by two massive stone piers 22 ft. by 9 ft., with a 25 ft. arch turned between them; these piers form the abutments from which an embankment is carried to the higher lying country. The abutment piers were carried down to a depth of 30 ft. below ground level and were founded on the rock.

As the bridge is built on a reef immediately above a rapid, great care had to be taken in making the cofferdams for the foundations, as the rock had to be blasted to get it out to a depth of 7 ft. Driving piles being out of the question, the method of fixing the cofferdams was as follows: A wooden frame of the necessary size was built on shore and planked complete with an annular space of 2 ft. between inside and outside planking. This shell was floated into position and weighed down on the rock, the river sand was then cleared away from the surface of the rock within the annular space, and clay well rammed was carried up between the boarding to top of dam. A ring of sacks filled with sand was then placed around this structure and distant about 18 in. from it, this space also being puddled, the outside of bags being protected by stone tipped in all round; the water was then pumped out of the center and blasting operations commenced. This style of dam was used throughout the construction of the foundations in a depth of 6 ft. of water with success. During a freshet they kept their place on top of the reef and were found to be quite water-tight on resuming operations. The foundations were all got in during the dry season, the river being then low, the highest flood level being 43 ft. above lowest water level. The water is generally low during May, June, July, and August: freshets begin to come down during September and October, the river falling again. In November the river begins to rise and reaches its highest in January and February, the river being fullest in the summer and low in the winter.

During the dry season the girders were built on the reef and lifted up whole to the tops of the piers; in the wet season they were put together on a pontoon, which was then floated between the piers, and the girders lifted therefrom.

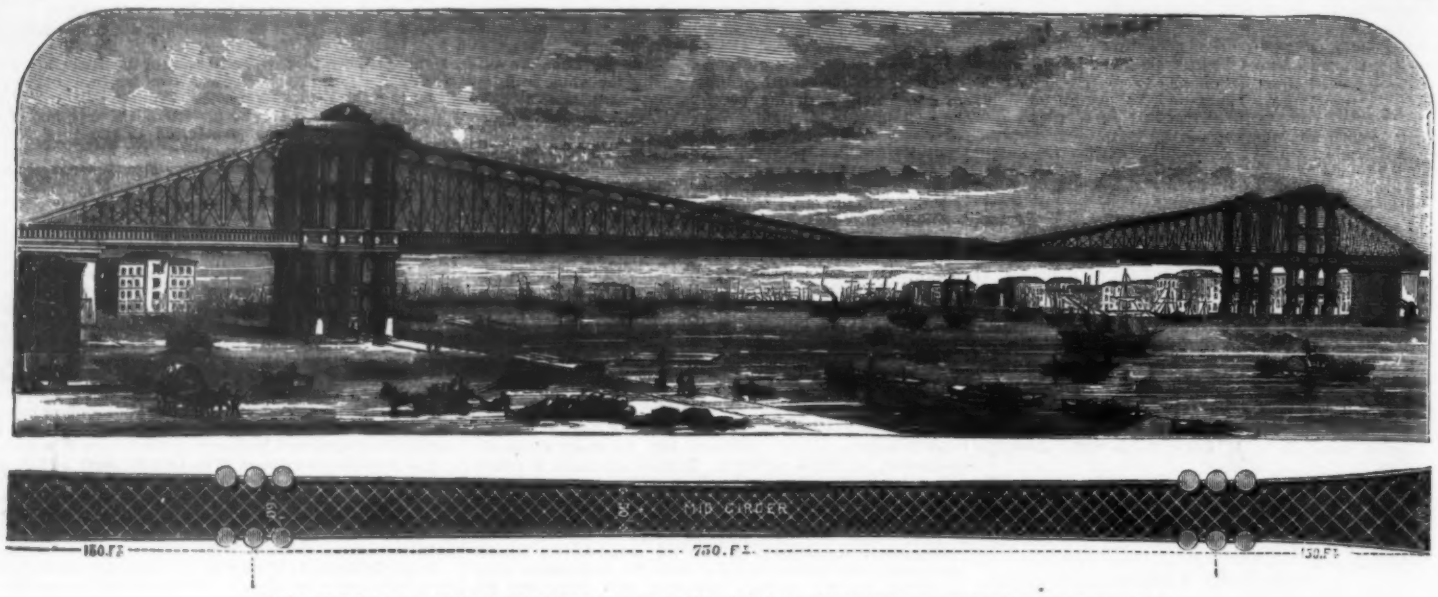
The whole of the ironwork and other materials had to be carried 300 miles up country in bullock wagons, and the structure was designed so that no part weighed more than 1½ tons, or was of greater length than 20 ft., so as to suit the buck wagons. The cost of carriage alone from the coast to the site of erection averaged 7s. 6d. per 100 lb. weight, the lowest price being 6s. and the highest 17s. per 100 lb. Good stone for the abutments and lime were found in the neighborhood of the bridge, but all other material had to be brought up in wagons from the coast. Had steel been used throughout in the construction of these bridges, the saving in carriage would have been about 15 per cent.—*Engineering.*



BRIDGE OVER THE ORANGE RIVER, CAPE OF GOOD HOPE.

PROPOSED HIGH-LEVEL BRIDGE OVER THE THAMES, LONDON.

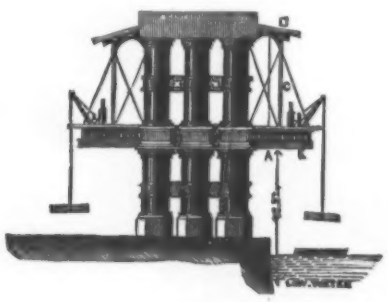
WE give on next page a design by Mr. Angelo J. Sedley, for a high-level bridge over the Thames near Little Tower-hill. The system proposed is that of Sedley's well-known cantilever and mid-girder combination, and the structure has a clear span of 750 feet, with a headway of eighty-five feet at low water, and two side spans of 150 feet each, these latter having a falling gradient of 1 in 50. The width of the bridge, including the side walks, is 60 feet. The mid-girder would have a length of 150 feet, the remainder of the span being composed of two cantilevers each 300 feet long. The approaches on the Tower-hill side are proposed to be 1 in 30, and carried on columns and girders, so as to interfere as



PROPOSED NEW BRIDGE OVER THE THAMES RIVER, LONDON.

little as possible with the property through which it passes. On the Surrey side the approach would be a roadway, also having a gradient of 1 in 50, disposed in a spiral, and having level resting places at intervals of 150 feet. Mr. Sedley's estimate for the bridge is £188,000, of which £47,500 would be for the foundations and piers. The approximate estimate including purchase of land, is £600,000.

The bridge would be erected without scaffolding, so that the waterway would not be interfered with during construction. The diagram annexed shows the method to be adopted. The foundations and columns being in place, and the latter having been tested, each with a load of 1,000 tons, the erection of the cantilevers would be commenced on both sides of



the piers simultaneously and equally. The portion over the piers being completed, a length of the bottom booms, A, with the diagonal bracing between, would be got in place and supported by the ties, B; this would be followed by the first sets of struts, C, and the top boom of the cantilevers, D, would then be put in place as far as the strut. This method of erection would be proceeded with until the cantilevers are completed on both sides of the towers, and the central girder would then be put in place. This girder would be erected and floated down into position to be lifted; it would rest on steel rollers.—*Engineering.*

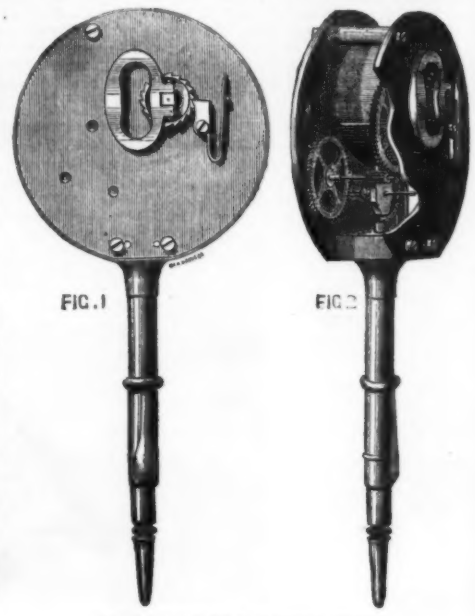
STEVENSON'S SUSPENSION RAILWAY.

AT the last meeting of the British Association, Mr. G. Stevenson, of Wantage, read a paper on street locomotives, in which he described the somewhat singular system of constructing tramways which we illustrate below. The drawing almost explains itself. The estimated cost of the proposed system is £2,500 per mile. Among the advantages claimed for it are that the roadway is not cut up, and that the resistance to draught is materially reduced.

It will be seen by a reference to the engraving that the mode of construction of the proposed lines consists in the arrangement made for supporting the rails by strong wrought iron clips suspended from brackets projecting from upright columns or pillars fixed on the outer edge of the pavements in streets or by the side of highways, or from archways, joists of buildings, or other places as desired, while the engines and cars are also suspended from the rails by means of steel carrying rods descending from the axles of small traveling wheels. It will also be seen that the great feature of this mode of traction consists in the formation of the permanent way, which is so constructed that the rails, and the timbers or trellis work girders carrying the rails, are placed so near together that only room is allowed for the free passage of the wheels and carrying rods between them, and also in the arrangements made for constructing the lines, when steam is used, at such a height from the ground, where it may be needful to do so, as not to interfere in any way with the ordinary traffic passing along the streets or highways. The rails may be affixed to buildings or archways, or to pillars, which will be bracketed on one side only for a single, and on both sides for a double line, as indicated. The strength, height, and bracket projections from the pillars, the distance apart, and the bearings for the rails will, of course, vary according to the strength and gauge of the lines required, and according to the materials of which they are constructed.—*Iron.*

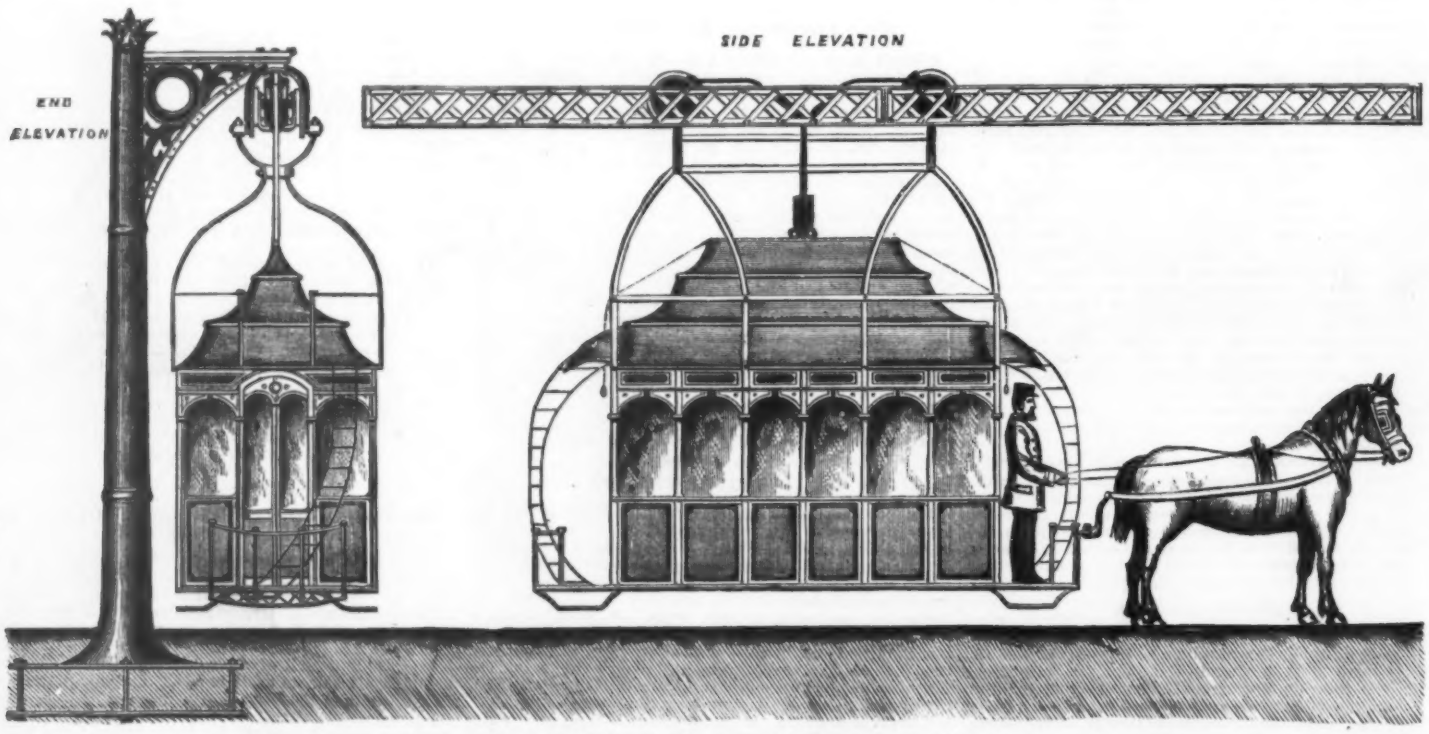
THE HOROGRAPH.

SINCE Mr. Edison's electric pen has been in use two other perforating pens have been brought before the public, one in which the pen or its needle is reciprocated by means of a small air cylinder, and the second in which the needle receives its motion from a cam worked by clockwork at the upper part of the penholder. This last has been called the "Horograph" by its makers, Messrs. Newton, Wilson & Co., Holborn, London, and is illustrated by the accompanying cuts. From Fig. 2 in these the general arrangement of the



SPRING PERFORATING PEN.

mechanism will be gathered. The needle is stopped and started at will by pressing or relieving the thumb piece, resembling a flute key, seen in both Figs. 1 and 2.



STEVENSON'S SUSPENSION RAILWAY.

The weight of the clock at the top of the pen makes it a little awkward to use for the first few minutes, but the hand rapidly becomes accustomed to this, and writing freely is soon acquired. A ring, however—not shown—is placed at the top of the case, from which the pen may be suspended by an elastic cord. The pen needle makes several thousand perforations through the stencil paper per minute, so that the stencil papers with any circular or sketch may be made at the usual rate of writing. From the stencil papers so made a very large number of copies may be produced by passing an ink roller over the upper perforated face. From 300 to 400 copies per hour may be made.—*The Engineering.*

CORLISS PUMPING ENGINE FOR PAWTUCKET, R.I.

THE accompanying engravings represent in elevation and plan a new pumping engine designed and built for Pawtucket, R. I., by Mr. George H. Corliss, the well-known inventor and builder of the Corliss steam engine.

The engine is compound, the smaller or high pressure cylinder being 15 inches in diameter and 30 inches stroke, and the low pressure cylinder 30 inches diameter, 30 inches stroke. Steam at 125 lb. pressure per square inch is admitted to the 15 inch cylinder, and is expanded about twenty times its original volume before it passes into the condenser from the 30 inch cylinder.

The steam cylinders, cylinder heads, and valve casings, are steam jacketed, and the induction valves of both cylinders are connected with a single lever for hand adjustment of the valves. The valve mechanism is substantially the same as

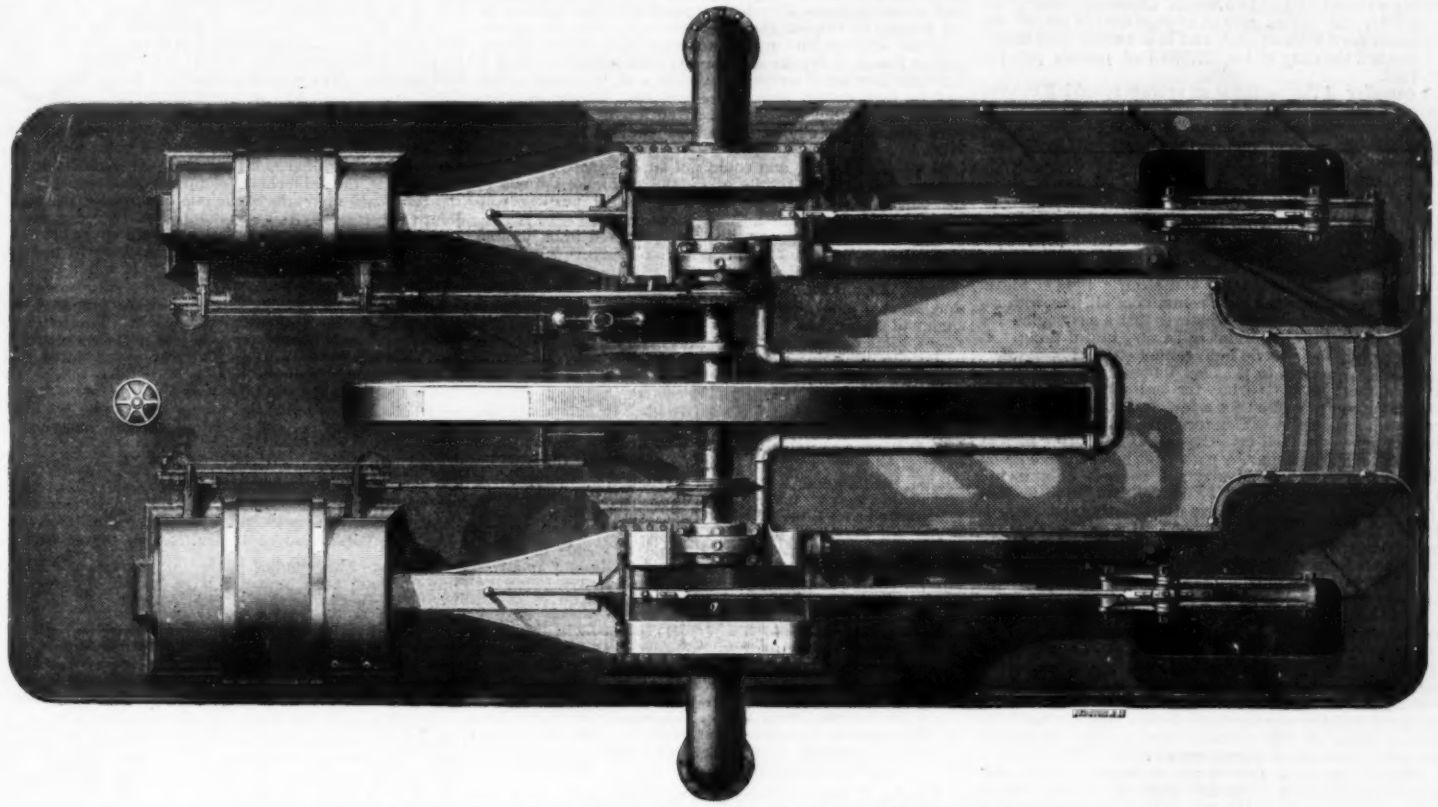


FIG. 1.—PLAN OF PAWTUCKET PUMPING ENGINE.

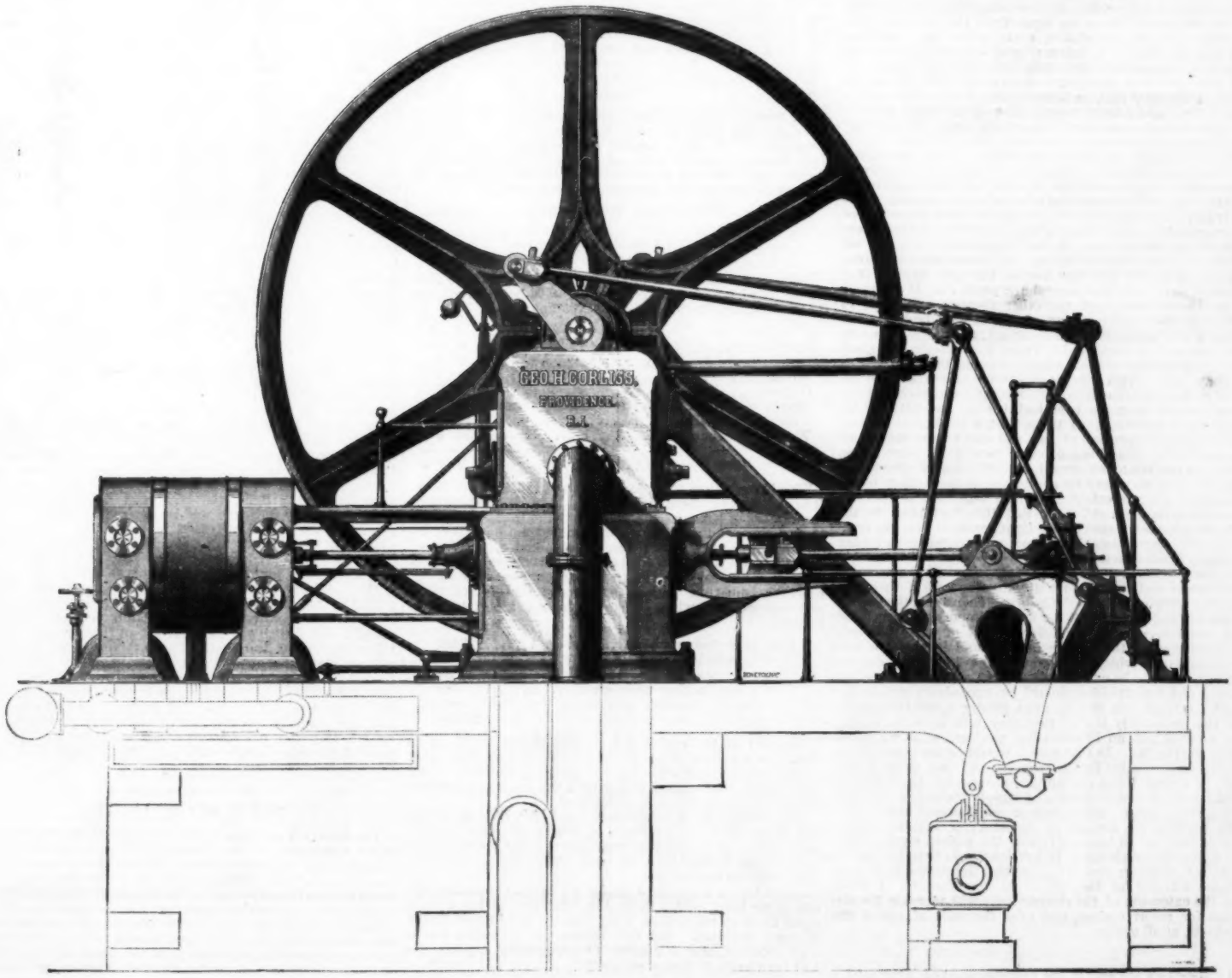


FIG. 2.—SIDE ELEVATION OF PAWTUCKET PUMPING ENGINE.

that of the great engine which furnished the power of the Machinery Hall at the Centennial Exhibition.

The pump plungers, which are keyed to the steam pistons, are each 10·52 inches diameter, and 30 inch stroke. The piston rods are 2·5 inches diameter, and communicate motion through connecting rods to the upright walking beams seen at the right in the engravings; these in turn rotate the heavy fly wheel through the medium of the connecting rods and cranks, the latter being arranged at right angles to each other. The engine has a governor which limits its velocity to 52 revolutions per minute.

During a recent trial of two weeks' duration, running ten hours per day, this engine gave an average duty of 104,357,654 foot pounds per 100 lb. of coal, and in a twenty-four hours' test it reached the duty of 133,522,060 foot pounds per 100 lb. of coal.

The capacity of the engine at an average speed is 3,060,000 gallons per day.

The engine exceeded the guarantee on the two weeks' test by more than 30 per cent, and on the twenty-four hours' test 33 per cent.

GAS FOR PRODUCING ELECTRIC LIGHTS.

MR. C. W. COOKE recently testified as follows before the Parliamentary Commission:

At the present moment what are the common motive powers employed for producing the electric light? Steam engines, of course, are the most common of all, but with regard to gas there is no doubt whatever that a gas engine for electric light is a very important and a very useful thing. It seems as though the electric light cannot start without offering some compensation to the gas interest which it takes away; for there seems to be, for ordinary purposes, for lights that are only wanted for a few hours, nothing that is so good as a gas engine. You turn on your gas, and you start your light. In fact, take the case of a building such as the Houses of Parliament. A dark November fog comes on suddenly; the steam may or may not be up. If it is up, you may have your light; if it is not up, you have to wait for it. But with the gas you have it instantly, and there is no loss of fuel when you turn it off. Hot air engines, or rather caloric engines, are used for certain special cases where it is difficult to obtain gas, and where it is also difficult to obtain steam engines. Then, again, Sir William Armstrong lights his library at night by a dynamo machine, driven by a waterfall nearly a mile from the house, and it drives machinery in the daytime. Then petroleum engines are used for the same purpose. I think that the extension of the use of gas engines which would be brought in by the extension of the electric light would be a very important thing for the gas people. Considerably more gas would be required to drive engines than would ever be used for lighting a place by the ordinary means. Dr. Hopkinson made a very interesting calculation in reply to the question: "If you have 100 cubic feet of gas to start with, in what way can you make it produce the greatest amount of light in an hour?" He said: "If burnt in the ordinary way you get about 300 candles out of it; and if burnt in a gas engine to drive a dynamo-electric machine, it would generate 3-horse power." Now, 3-horse power will drive a Siemens machine which will produce 3,000-candle power; that is 3,000 against 300, or ten times the light from the burners. He also made a similar calculation as to petroleum. Starting with half a gallon of petroleum, and burning that for an hour, it would produce 700 candle light burnt in lamps. If that half gallon of petroleum were burnt in a petroleum engine at the same rate, he believed that it would develop 5-horse power; and 5-horse power, of course, would drive a very powerful dynamo-electric machine, and a proportionately enormous increase of light would be produced.

Then you think that the scare which at one time arose that the electric light was going to extinguish gas light was not justified? I do not think it was, for there can be no question that, if the electric light comes into general use—and it can only come into general use for those places where it is practicable—it will leave a large number of places where it is not applicable; and, if you illuminate one street by the electric light, the side streets and those near it cannot afford to be in the dim darkness of the poor lighting that they now have, and they must burn more gas. If one theater has the electric light, the other theaters will have to burn more gas, and in every case you will find that the standard of illumination will be raised; therefore, more and better gas will be employed. There was exactly the same scare about candles and oil when gas came in, about 80 or 90 years ago. With regard to candles, there can be no question that since the introduction of gas we have had far better candles than we ever had before, and oil and all things have improved. I think that it is due to a great extent to the competition of gas, and also to the raising of the standard of illumination. Our forefathers were accustomed to the wretched rushlight. If a better illuminant comes in, it is necessary for everybody to have that better illuminant, and the others go to the wall. It is the survival of the fittest; and I think that the effect must be the same on gas, that if the electric light comes in the gas companies will congratulate themselves on a friend rather than an enemy coming to them.

In fact, through the electric light, they may get much more power and much more illumination out of their gas than they have had hitherto? Quite so. Then again the supply of gas for gas engines will be a very important item; and they will have to prepare a different sort of gas. The gas for lighting is not the best for heating, and it is not the best for gas engines, which are used for explosion. The gas for lighting ought to be exceedingly rich in carbon; the gas for heating and for explosion should be excessively rich in hydrogen, because you thereby get a greater explosive power; and the probability is that that they will have to supply two sorts of gas, an illuminating gas, and what we might call a motive gas. In that case it would be necessary to lay down separate mains for the purpose, and that must, I suppose, be a good thing for the gas companies, because they would have a double source of supply instead of a single one. Then, again, retort carbon will become more valuable, because the amount in demand for making carbon pencils will be so increased; and the carbon comes from the gasworks originally. It has been said that gas can be made for nothing; that is to say, that the products of combustion will pay for the cost of its manufacture. I think that the extension of the electric light will increase the demand for retort carbon, and raise the value of one of the products, at all events.

In digging a channel in the neighborhood of Neuchatel a lacustrine canoe, very nearly twenty-three feet long, has been found. It has been placed in the Cantonal Museum.

THE ELECTRIC LIGHT.

AFTER more than four months' experience and much careful investigation of the Jablochkoff system of electric lighting upon the Thames Embankment, Sir Joseph Bazalgette and Mr. T. W. Keates have presented a joint report on the results obtained to the Metropolitan Board of Works. We regret that the space at our disposal will not allow us to reprint this report, which is, in our opinion, the most practical and valuable official document on the subject that has been issued from any source. We propose, however, to review its contents as fully as possible. After a prolonged trial of the Jablochkoff system, applied to public lighting in the Avenue de l'Opéra and other places in Paris, the Société Générale d'Electricité made proposals both to the Metropolitan Board of Works and the city authorities to install a sufficient number of lamps in London, and to secure a fair trial for their system here. This proposal having been accepted, the Thames Embankment and the Holborn Viaduct were selected as eligible situations for the experiments. With regard to the latter, it will be remembered that the trial was a short one, and could not be considered as satisfactory either in its results or in the deductions made in the official report, so that but little useful purpose was served by this installation.

On the Embankment the distance proposed to be lighted lay between Westminster and Waterloo bridges—7,063 ft.—and every alternate one of the existing lamps upon the parapet was adapted for the purpose, twenty lamps in all being thus fitted. The motive power employed was a portable engine of 20 nominal horse power, supplied by Messrs. Ransomes, Sims & Head, and the report calls especial attention to the admirable and steady working of this machine during the whole of the trials. Public lighting of the Embankment was commenced on the 13th December last, and after a month's regular working, it was decided to commence the series of investigations which are embodied in the report and give to it an especial value. It was decided to ascertain exactly the power required to produce the light, the cost incurred, the photometric value obtained, and the comparative cost of the electric lighting and of gas illumination. The trials lasted over a period of 12 days from the 24th January to the 5th February, and the time of trials was extended each night to a period of 5·5 hours, all the twenty lights being operated together, except when it was desired to ascertain the results of working separate circuits. The following data refer to the whole of the 12 days' experiments:

Mean pressure of steam in boiler	50	lb.
Mean temperature of feed water	60	deg.
Fuel consu'd per indicated horse power,	3·86	lb.
Mean indicated horse power	23·34	
Water used per hour	85·89	gals.
Fuel used per hour	90·26	lb.
Mean speed of engine, per minute	143·36	rev.
Power absorbed in driving engine and intermediate shafting	5·19	HP.

A series of careful investigations showed that the power required under different conditions was as follows:

	HP.
1. To drive the two Gramme machines without current passing	7·21
2. To drive the two Gramme machines with the current passing	9·17
3. To drive machines, and one circuit of 5 lights	13·17
4. " " " two circuits of 10 "	17·93
5. " " " three " 15 "	20·75
6. " " " four " 20 "	23·53

The mean of the 12 nights' experiments with the 20 lights was somewhat less than this, however, having been 23·34 horse power. It will be noticed that the power required per light decreased rapidly with the number of lights, and deducting the 5·19 horse power absorbed by the engine and intermediate shafting, the amounts varied as follows:

To produce 5 lights 1·59 HP. per light was required.
" 10 " 1·27 " " "
" 15 " 1·03 " " "
" 20 " ·90 " " "

Taking next the cost of producing the light, we find that for the 12 nights of trial, or a period of 66 hours in all, the items stand as follows per night of 5·5 hours:

	£	s.	d.
498·5 lb. coal, at 17s. per ton	0	3	9·5
98 " for getting up steam	0	0	9
Wood	0	0	3
Oil, etc	0	1	7
Wages of driver, attendant on lamps, candles, etc	0	13	4
Wages of assistants	0	10	0
Total	£1	9	8·5

This is equivalent to 17·8d. per light, or 3·24d. per hour. It is obvious that these figures would have been reduced had the number of lights been greater, and the time of running longer, since the wages, fuel, etc., would not have been increased in proportion to the results obtained, as will be evidenced by the more extended experiments about to be commenced on the Embankment. To the expense of working, however, must be added the interest on cost of plant and depreciation, which is stated in the report to be as follows:

Cost of engine, complete	£495
" two Gramme machines	360
" belting, etc	35
" conducting cable, etc	390
	£1,280

The cost of the engine for an installation of 20 lights should be less than given above, as one of half the power would have been sufficient for the purpose, and this would have reduced the capital outlay to £990, on which interest and depreciation should be calculated.

The value of the light obtained next occupied the attention of the officers of the Board of Works, and this was estimated under three different conditions: 1, the naked light; 2, the light shielded with an opal globe; and 3, the same light within a frosted globe. An ordinary photometer was employed with a standard sperm oil lamp, consuming 925 grains per hour, with a flame 2 in. long, and giving a light equal to 16 sperm candles, being exactly equal to the Parliamentary standard. By this means the following results were obtained, after a number of preliminary experiments had been made to insure accuracy:

1. The naked light (mean of 8 experiments), = 378·1 candles.
2. The light within an opal globe (mean of 3 experiments), = 154·9 candles.
3. The light within a frosted globe (mean of 2 experiments), = 265·0 candles.

So that the opal glass reduced the amount of lighting 59 per cent., and the frosted globes 29·9 per cent.

To obtain the best comparison with gas, experiments were conducted with some of Sugg's large-sized burners. To produce a light with them equivalent to 155 candles, the consumption of gas equaled 48 cubic feet an hour, and for a 264 candle light, the consumption was raised to 83 ft. The cost of these lights per hour was respectively 2d. and 3·5d.

As we have seen, the cost of producing the electric light was 3·24d. per hour, but to this has to be added the interest on plant and depreciation, as well as the cost of the Jablochkoff candles. The capital expenditure being taken at £990; the interest on this sum at 5 per cent. would be £49 10s., and the depreciation, £99 a year, taken at 10 per cent. This amount, divided for the year over twenty lights, and assuming that each lamp works 3,600 hours a year, would give a sum of ·20d. per hour and per light. As regards the cost of the candles, the Jablochkoff company commenced by charging the Board of Works at the rate of sixpence per hour per lamp; subsequently this was reduced to fivepence, and more recently, they have offered to maintain the whole of the lamps at fivepence per hour each, this sum to include all charge of wages, fuel, repairs, etc. It will thus be seen either that the company has been charging an unreasonably high price for the candles, or that they are prepared to continue lighting the Embankment at a loss. The latter we do not suppose in this case, especially as in the recent report of M. Cernesson to the Ville de Paris, we find it stated that the cost of the candles should not be more than one penny an hour, and that they can be supplied at this rate. The Board of Works have assumed the lowest price to be double this, and their estimate of the total cost of each lamp per hour stands thus:

Cost of working	3·24d.
Interest and depreciation	·49d.
Candles	2·00d.
Total	5·73d.

The cost of the candles is the only uncertain element in this estimate; but if it errs, it is on the side of excess. Comparing this cost with that of gas we have:

Cost of electric light per hour	5·73d.
Cost of gas of power equivalent to electric light in opal globe	2·00d.
Cost of gas of power equivalent to electric light in frosted globe	3·50d.

It will thus be seen that according to these figures, the same light could be obtained by gas for much less, or rather more than half the cost of the electric light, according to the mode of obscuring it. It will be seen from these figures that the present report, besides being the most carefully prepared one on the subject yet issued, also undoubtedly presents the Jablochkoff system to the greatest advantage, probably on account of the excellent nature of the installation and motive power; but even under these favorable circumstances, the comparison with gas is eminently favorable to the latter. The twenty lamps on the Embankment parapet replaced 119 jets of gas, which gave collectively a light of 1,336 candles, with an hourly expenditure of something under 500 ft. per hour, and costing about 20d. per hour, as compared with 114d. per hour for the electric light. On the other hand, the latter was far more powerful than the former—7,560 candles as compared with 1,336; but this quantity is reduced by the opal globes to 3,098 candles, or 2·3 times the gaslight; and with frosted globes to 5,300 candles, or about fourfold the gaslight, but at 5·7 times its cost. But we do not think it can be fairly urged that the Jablochkoff lights on the Embankment illuminate that wide thoroughfare much more efficiently than do the gas lamps, partly because of the unfortunate position of the former, by which one-half of the light is thrown into the river, partly on account of the absence of suitable reflectors, resulting in the wasteful diffusion of a considerable portion of the remaining light skyward, and also because the 119 points of illumination given by the gas result in a more perfect diffusion than do the 20 lamps upon the river wall. Certainly, the extra light obtained is entirely disproportioned to the cost of obtaining it, and very different financial results must be proved before it can be hoped that the Jablochkoff system will meet with favor among municipal boards and ratepayers. We believe that considerable economies are still to be effected in the power used; this will be partially demonstrated by the extended experiment about to be undertaken on the Embankment, when 40 lights will be driven from the engine at Charing Cross, and the whole thoroughfare will be illuminated from Westminster to Blackfriars. It will probably be found under these new conditions that the consumption of power will fall considerably below a horse power per light, the expense of attendance will remain practically the same, and the interest of plant and depreciation will not be increased in proportion to the extra number of lamps. Attention should also be directed to utilizing, by suitable reflectors, a large part of the light now lost, and also to improved methods of shielding the lights without so large a sacrifice of illuminating power. It is probable, too, that the candles will be produced more cheaply, and about one penny per lamp per hour will be saved in this direction. But, even if all these results be attained, the cost of illumination by the Jablochkoff system will still remain higher than by gas, and we think it more than doubtful if the public will be contented to pay the necessary difference. At the same time it must not be forgotten that in the hands of the Board of Works a greater economy has been obtained for the system than was previously recorded, and it is possible that this economy may yet be pushed to farther limits than our present experience warrants us to hope.—*Engineering.*

THE ELECTRIC LIGHT.

PROFESSOR TYNDALL, in lately giving evidence before the select committee of the British Parliament appointed to consider the subject of electric lighting, Dr. Lyon Playfair presiding, gave an interesting history of the progress of the electric light from the time of the discovery of electricity by Volta to the present day, illustrating his subject by numerous experiments with electrical machines. He pointed out that the voltaic battery had been proved to be too expensive a mode of producing electricity, as the waste of zinc plates and chemicals was so great. Oersted, Ampère, and Arago followed with inventions, and the analogy between electricity and magnetism was demonstrated. Professor Faraday had

taken up the subject, and his efforts, in the main, had led to the great discoveries which had been made. The professor had not applied his discoveries to the practical purpose of producing electric heat and light on an economic scale, but, like a true man of science, he predicted that those results, which were exceedingly feeble in the first instance, would receive their full development hereafter. There had been great discoveries made in regulators for electric lights recently. They had been used for years at the South Foreland Lighthouse, but they were of a somewhat complicated character. The Jablochkoff candle was an invention which enabled them to do away with the regulators. This had been used on the Thames Embankment and elsewhere, and was now pretty well known. It consisted of two pieces of carbon, separated from each other more or less by an insulating substance, such as plaster of Paris. There was a piece of carbon at the top of the candle, but this was destroyed when the current was turned on, which current traveled up one of the sticks and down the other. The current was alternating in the candle, so that the carbons should burn equally. No doubt the great source of light was the incandescence of the solid carbons. It could be produced to a degree of almost solar intensity. They heard, through the newspapers, that this light had a bluish tint, and that many people objected to it for that reason. With regard to the amount of light a single Siemens machine was capable of giving, experiments conducted at the South Foreland had been made with a medium-sized machine, and the light given amounted in round numbers to 6,000 candles. An enlarged machine was then constructed, but it had not been brought very much into operation of late, for the reason that its power was so considerable and that it required such great care to prevent combustion of the commutator. He did not think a 10,000 candle machine could be made to give 10 lights of 1,000 candles each. There was nothing in science or practice to show that they could divide the current in that way without losing a great deal of electricity. If the wires were not of equal conducting power there would be a great loss of electricity. Certain impurities were produced in the burning of gas, and though these impurities would be produced in the case of charcoal points, it would not be so much so as in the case of gas, for the reason that the oxygen of the air was not essential to the production of the electric light, which could be burnt with great splendor in a vacuum. Also the carbonic gas would be infinitely less in the one case than the other; for in one case its presence was an accident, in the other a necessity. It might be possible that nitrous acid would be given off by the carbon points, and whether that would injure books more than gas was a question which deserved attention; at present they had not sufficient experience of it to say. In answer to Lord Lindsay, witness stated that complaints were made at the Athenæum Club that the gas would injure the books. In consequence of that Professor Faraday investigated those complaints, and the evidence in favor of those complaints was very feeble.

With regard to fluctuations in the electric light, he must say nothing was more unpleasant to the eye, but the advance of late years in the direction of obtaining a steady light was very great. In reply to Mr. Puleston, witness said that although there were great difficulties in the way of Edison applying the electric light successfully to domestic purposes, one was hardly entitled to say he would not be able to overcome them. In Ireland gas had been applied to lighthouses with an excellent result. It would not do to have the electric light exposed, because to the eye it would be intolerable. He had been very much pleased with the electric light used in the *Times* office, and believed it was found better and more convenient than any other form of light. There was a large source of power in gas itself which was unused, and which might be applied for heating purposes more than at present was the case. So much was that the case that he did not believe that gas would be beaten out of the field by the electric light.

Dr. Siemens, giving evidence before the same committee, described the dynamo-electric machines at present in use, such as the Siemens, the Gramme, Lontin, and Wilde. In all of these the Siemens and Wheatstone principle of producing alternate currents by rotation had been carried out. He had compared the power of coal in light production in the case of electricity and gas, and had found that while in the former case a light of a thousand standard candles could be given by 3 lb. of coal, 312¼ cubic feet of gas, produced from 56 lb. of coal, would have to be consumed by an Argand burner to give a light of a thousand candles. The electric light, therefore, was very economical in regard to the amount of energy obtained from the fuel, but when the light was divided its power decreased. The economy rapidly decreased with each subdivision which was made in the unit of a thousand candles. The electric light had been applied to lighthouses and also to ships, and in the latter case a very serious collision had been avoided by its means on the Atlantic not very long ago. The captain on board the vessel using the light by its rays saw a huge, dark mass in front of him, which it would have been impossible for him to see with the ordinary lamp At the same time the people on board the other vessel (which, by the way, was an emigrant ship) saw the electric light and she was got out of the way, which she would not have been able to do if any other light had been used. The captains maneuvered their ships so as to avoid a collision, but as it was they actually came within a yard of each other. He believed the electric light was used on board some of the Russian ships of war. The Board of Trade regulations at the present moment prevented ships from using it in this country, although when the incident to which he had referred happened he had written to the Board of Trade suggesting an interview with the captain of the vessel. He had been met, however, by the observation that the captain had been guilty of an illegal act. If the electric light were allowed to be used on board ship, he thought it would be adopted by all the great Atlantic-going steamers. The electric light on a ship should be fixed higher up than the oil lamp in order to avoid throwing a glare of light on the surface of the water near the ship. The electric-light, he believed, could be applied with advantage to large halls and warehouses, and the cost in the case of the Albert Hall was £1 7s. 6d. per night, whereas the cost of lighting by gas was £4 3s. 6d. Besides the question of cost, considerable sanitary advantages flowed from the use of electricity in greater purity of the atmosphere, obtained through the fact of there being little or no combustion of oxygen in the case of electricity, and a large amount in the case of gas. The acoustic properties of a hall lighted by electricity were better than where gas was used, and the former description of lighting was of advantage in places where colors were examined—in warehouses, for instance, and in the photographer's studio. He did not think there was any insuperable difficulty in the way of dividing the electric light. The only difficulty was one of cost. Sub-division, in time, no doubt, would become a matter of absolute necessity, but it should never be carried beyond the point which necessity dictated. Towns might be lit by the electric light, and the engines which created the electricity at night could be utilized during the day for the driving of sewing-machines, light lathes, and so on. He did not think the danger of interfering with the telegraph wires would be appreciable in the case of towns lit by electricity, and the difficulty of leakage, in his opinion, might be got over by proper insulation. Even if the electric light came to be commonly used, he did not think it would greatly interfere with the consumption of gas, which would still have to be used for many lighting purposes and also for heating. That the electric light was being largely used was evidenced by the fact that during the last two years his firm had constructed machines to the value of £57,000. The matter was not now merely theoretical.

By Lord Lindsay: No doubt the electric lamps in use were capable of great improvement.

By Mr. Puleston: He found that the most effective way of lighting a chamber was to throw the light against the ceiling when it was white or light colored, and in that way when the source of light was not seen, or very dimly seen, the light was reflected from the roof or ceiling and the sides of the apartment. He did not think, however, that this kind of lighting could be applied to the House of Commons, although the House could be lighted in such a way by electricity as to incommode the eye much less than was the case at present.

By Mr. A. Moore: To his mind the electric light would be safer than gas in theaters.

By Earl Percy: The light in the Albert Hall burnt for six hours, but he was at present engaged in the construction of a lamp which he hoped would burn for 20 hours. The light which Edison proposed, as it would be procured from heated iridium or platinum, would be much more controllable than the present carbon light. At present, however, the former kind of light had hardly got beyond the experimental stage.

Mr. C. W. Cooke, civil and consulting engineer, was also examined, and stated, among other things, that he did not think there was any reason for the scare which had occurred in the public mind. Gas would not be done away with any more than candles had been abolished, but improved gas would be supplied.

The committee again adjourned.—*London Times.*

POLARIZED LIGHT IN GASES.

THE rotation of the plane of polarized light in gases has just been effected by two German experimenters, MM. Kundt and Röntgeu, with the aid of powerful electro-magnets, made by passing the current from 64 Bunsen cells through six coils of thick wire (each comprising 400 turns) surrounding a tubular iron core. They showed that saturated vapor of carbon bisulphide at 100° C. rotates the plane of polarization of light in the magnetic field produced by this electro-magnet.

TRANSMISSION OF POWER BY ELECTRICITY.

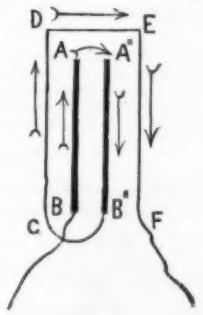
PROFS. HOUSTON and Thomson have experimentally shown at the Franklin Institute that powerful electric currents can be conducted by very fine wires. They sent the current generated by one dynamo-electric machine through a wire ·004 inch in diameter to a second machine, which, working reversely, gave off considerable power.

MAGNETIZATION OF NICKEL.

ACCORDING to M. Henri Becquerel, in the *Comptes Rendus* for Jan. 20, bars of nickel become saturated with magnetism much more promptly than iron bars, and hence are better suited for temporary magnetization—a fact which might be useful in telegraphy. Cobalt gives results similar to nickel.

AN ELECTRIC BLOW-PIPE.

IN a recent communication to the French Academy of Sciences, M. Jamin brought forward a modified form of the electric candle, familiar to English electricians as the invention of Mr. Wilde and M. Rapieff. This candle consists of two upright carbon rods side by side, as in Jablochkoff's candle, but without any other insulator between them except the air, and the arc is driven to the tip of the candle by the electro-dynamic action of the current on itself. M. Jamin multiplies this action by winding one of the electrodes round the candle, as shown in the accompanying figure, where A B and A′ B′ are the carbon rods, and C D E F is the electrode coiled in turns round the candle, so as to



keep the direction of the current according to the arrows. When the action of the rectangle of wire on the arc is sufficient, the arc, A A′, lengthens out and flares up like a gas flame towards the attracting current from D to E. M. Jamin allows it to play upon a piece of lime, or magnesia, or zirconium, like the oxyhydrogen flame in the Drummond lamp. This has the effect of trebling the amount of light given off, and toning its quality from violet to yellowish green or white by admixture of the green rays from the chalk. The heat of the arc is so intense as even to fuse the chalk, and hence M. Jamin recommends the arc to chemists as perhaps the most powerful blow-flame known. The multiplying effect introduced by M. Jamin appears to us to be the chief novelty in this candle, for, if we mistake not, M. Rapieff has also applied chalk to the arc in the manner described.

MAGNETISM AND CLOUDS.

THE auroral or magnetic cirrus is the name given to a species of symmetrical cirrus often seen during auroral displays, and the Rev. Samuel Barber, in the latest *Quarterly Journal of the Meteorological Society*, argues that they are caused by the magnetic action of the earth or by atmospheric electricity. Cloud forms would seem to exist in the air at all times, in an invisible state, until a certain degree of condensation from the effect of external force is attained. Magnetic or electric disturbances are probably forces with this power. Mr. Barber was led to this conclusion by observing an ordinary lunar halo, seen through cirrus clouds (of the kind popularly known as Noah's Ark), on the night of Oct. 23, 1877, to change its form under the influence of the luminous waves of an aurora.

THE SPECTROSCOPE AND HIGH TEMPERATURES.

THE employment of the spectroscope in the comparative measurement of high temperatures has been described by M. Crova, of Montpellier, France, before the Académie des Sciences. According to his description, this instrument can be employed to measure temperature hitherto incalculable. The process which he recommends is thus described: Having first adopted some arbitrary standard, he proceeds to examine the flames of incandescent bodies with the instrument, and reduces them, by the interposition of obstructives of known value, to the same level as that of the standard. To this combination of devices he applies the name of spectro-photometer. Professor Crova adopts as his standard the heat emitted by an ordinary moderator lamp burning oil, which he fixes at 1,000°. In making his comparisons, he finds the heat of a piece of platinum heated to redness to be 524°; the same at white heat, 810°; a regulation stearine candle, 1,162°; an Argand burner of common coal gas, 1,373°; lime light, oxygen, and coal gas on lime, 1,806°; the electric light, sixty Bunsen elements, 3,060°; and the light of the sun, 4,049°.

THE PREPARATION IN A STATE OF PURITY OF THE GROUP OF METALS KNOWN AS THE PLATINUM SERIES, AND NOTES UPON THE MANUFACTURE OF IRIDIO-PLATINUM.*

By GEORGE MATTHEY.

IN this paper it is not my intention, nor should I be able, to refer generally to the results of work in the various branches of platinum metallurgy carried out by my firm, who, as is well known, have been associated with the development of this special field of industry from its earliest infancy, but I shall confine myself simply to that section of it upon which my personal attention has of late years been specifically concentrated in order to meet and comply with the requisition of the Bureau Internationale des Poids et Mesures, the Sections Françaises de la Commission Internationale du Mètre, and of l'Association Géodésique Internationale (all of them important scientific committees, formed with the object of arriving at an accurate and definite solution of the long agitated question of standard weights and measures), and also at the demand of the French Minister of War for an alloy the best adapted for the manufacture of the international meter and kilogramme standard, and the geodesique rule, and in my endeavor to solve this difficult problem I have had the great advantage of being able to consult those distinguished men, MM. Henri Sainte-Claire Deville and Henri Debray, of Paris, and have also had the benefit of the excellent and valued advice of M. Stas, the celebrated Belgian chemist, to all of whom the scientific world owe so much, and to whom I desire to offer my warmest thanks.

In a paper of this kind it would be superfluous for me to enter into any of the already published details concerning the existence and collection of what is known as platinum dust or mineral. It is sufficient for me to observe that the six metals (of which platinum is the chief) usually found more or less in association in their native state, present characteristics of interest beyond their metallurgic utility, which are perhaps worth alluding to *en passant*. It is, for instance, a curious fact that the group should consist of three light and three heavy metals, each division being of approximately the same specific gravity, the heavier being (in round figures) just double the density of the lighter series.

Thus we find osmium, iridium, platinum forming the first division, of the respective specific gravities of 22·43, 22·39, 21·46, while ruthenium, rhodium, and palladium are represented by the figures, 11·48, 11·36, 11, the average densities of the heavy and light divisions thus being respectively 22·43 and 11·25.

But a more interesting and important classification is what I may designate as a first and second class series, from the more important view of their relative properties of stability. Thus platinum, palladium, and rhodium form the first or higher class, not being volatilizable in a state of oxide; iridium, osmium, and ruthenium forming the second or lower class, their oxides being more or less readily volatilized.

The oxide of iridium is effected at 700° to 800° C., and entirely decomposed at 1,000°, while osmic and hypo-ruthenic acids are volatilized at the low degree of 100°, the latter exploding at 108°. The chlorides of these metals can be sublimed at different temperatures (as also the protochloride of platinum).

I now propose to give a short description of the methods I have employed for preparing the pure platinum and iridium necessary for the manufacture of the alloy, which I call "iridio-platinum," and it is upon the distinguishing characteristics above mentioned that my method of separation is chiefly founded.

PLATINUM.

The preparation of this metal to a state of purity is an operation of extreme delicacy. I commence by taking ordinary commercial platinum; I melt this with six times its weight of lead of ascertained purity, and, after granulation, dissolve slowly in nitric acid diluted in the proportion of 1 volume to 8 of distilled water. The more readily to insure dissolution, it is well to place the granulated alloy in porcelain baskets such as are used in the manufacture of chlorine gas for holding the oxide of manganese. When the first charge of acid is sufficiently saturated, a fresh quantity should be added until no more action is apparent. At this stage the greater part of the lead will have been dissolved out, together with a portion of any copper, iron, palladium, or rhodium that may have been present. These metals are subsequently extracted from the mother liquors, the nitrate of lead by crystallization, and the remaining metals by well known methods.

The metallic residue now obtained will be found in the state of an amorphous black powder (a form most suitable for further treatment), consisting of platinum, lead, and small proportions of the other metals originally present, the iridium existing as a brilliant crystalline substance insoluble

* A paper read before the Royal Society.

in nitric acid. After digesting this compound in weak aqua regia, an immediate dissolution takes place of the platinum and lead, leaving the iridium still impure, but effecting a complete separation of the platinum.

To the chloride of platinum and lead, after evaporation, is added sufficient sulphuric acid to effect the precipitation of the whole of the lead as a sulphate, and the chloride of platinum, after dissolution in distilled water, is treated with an excess of chloride of ammonium and sodium, the excess being necessary, in order that the precipitated yellow double salt may remain in a saturated solution of the precipitant. The whole is then heated to about 80°, and allowed to stand for some days; the ammonio-chloride of platinum will settle down as a firm deposit at the bottom of the vessel, while if any rhodium, as is generally the case, is present, the surface liquor will be colored a rose tint, occasioned by a combination of the salts of the two metals.

The precipitate must be repeatedly washed with a saturated solution of chloride of ammonium, and subsequently with distilled water charged with pure hydrochloric acid. This is necessary for its purification. The small quantity of the double salt which will be taken up and held in solution is, of course, recovered afterward. Rhodium may still exist in the washed precipitate, which must, therefore, not be reduced to the metallic state until its separation is completed, and this is best effected by mixing with the dried compound salts of chloro-platinate and chloro-rhodiate of ammonia, bisulphate of potash, with a small proportion of bisulphate of ammonia, and subjecting to a gradual heat brought by degrees up to a dull red in a platinum capsule, over which is placed an inverted glass funnel. The platinum is thus slowly reduced to a black, spongy, porous condition, free from water, nitrogen, sulphate of ammonia, and hydrochloric acid, the rhodium remaining in a soluble state as bisulphate of rhodium and potash, which can be dissolved out completely by digesting in boiling distilled water. A small quantity of platinum will have been taken up in a state of sulphate, but is regained by heating the residue (obtained on evaporation) to redness, at which heat it is reduced to the metallic condition, the rhodium salt remaining undecomposed.

By the method above described the platinum is freed not only from rhodium, but from all other metals with which it may have been contaminated, and is brought to a state of absolute purity, of the density, 21·46, the highest degree obtainable.

IRIDIUM.

In the preparation of this metal, when intended to be used for the manufacture of iridio-platinum alloy, I have arrived at freeing it to the utmost possible extent from all its associate metals, except platinum, disregarding the presence of the latter, the proportion of which, once determined, would only form matter of calculation in the final operation of mixing my alloy.

In practice, the purest iridium which can be obtained from its ordinary solution (deprived of osmium by long boiling in aqua regia, and precipitated by chloride of ammonium) will almost invariably contain traces of platinum, rhodium, ruthenium, and iron, in a condition suitable for my further treatment. By fusion at a high temperature with an admixture of bisulphate of potash, the rhodium is almost entirely removed, any remaining trace being taken up together with the iron in a later operation.

The iridium so far prepared is melted with ten times its weight of dry caustic potash and three times its weight of niter in a gold pan or crucible, the process being prolonged for a considerable time to effect the complete transformation of the material into iridiate and ruthenate of potash, and the oxidation of the iron. When cold, the mixture is treated with cold distilled water. The iridiate of potash of a blue tinge will remain as a deposit almost insoluble in water, more especially if slightly alkaline, and also the oxide of iron.

This precipitate must be well washed with water charged with a little potash and hypochlorite of soda until the washings are no longer colored, and then several times with distilled water.

The blue powder is then mixed with water strongly charged with hypochlorite of soda, and allowed to remain for a time cold, then warmed in a distilling vessel, and, finally, brought up to boiling point until the distillate no longer colors red weak alcohol acidulated with hydrochloric acid.

The residue is again heated with niter and potash water charged with hypochlorite of soda and chlorine until the last trace of ruthenium has disappeared.

Further, to carry out the purification, the blue powder (oxide of iridium) is redissolved in aqua regia, evaporated to dryness, redissolved in water, and filtered.

The dark-colored solution thus obtained is slowly poured into a concentrated solution of soda and mixed with hypochlorite of soda, and should remain as a clear solution without any perceptible precipitate, and, subjected in a distilling apparatus to a stream of chlorine gas, should not show a trace of ruthenium when hydrochloric acid and alcohol are introduced into the receiver. In this operation the chlorine precipitates the greater part of the iridium in a state of blue oxide, which, after being collected, washed, and dried, is placed in a porcelain or glass tube, and subjected to the combined action of oxide of carbon and carbonic acid, obtained by means of a mixture of oxalic acid with sulphuric acid, gently heated.

The oxide of iridium is reduced by the action of the gas, leaving the oxide of iron intact; the mass is then heated to redness with bisulphate of potash (which will take up the iron and any remaining trace of rhodium), and, after subjecting it to many washings with distilled water, the residue is washed with chlorine water to remove any trace of gold, and finally, with hydrofluoric acid, in order to take out any silica which might have been accidentally introduced with the alkalies employed or have come off the vessels used.

The iridium, after calcination at a strong heat in a charcoal crucible, is melted into an ingot, and, after being broken up and boiled in hydrochloric acid, to remove any possible trace of iron adhering to it through the abrasion in breaking up, should possess, if perfectly pure, a density of 22·39, but as iridium, prepared even with the utmost care, will still contain minute though almost inappreciable traces of oxygen, ruthenium, rhodium, and possibly iron, the highest density I have yet attained is 22·38.

ALLOY OF IRIDIO-PLATINUM.

This compound metal possesses physical properties of great value, forming a beautiful example of the effect of a careful combination of the opposite characteristics of its component parts. Thus the extreme softness and expansiveness of pure platinum, and the brittleness and excessive hardness of pure iridium, produce, by combination in judicious proportions, a perfect and homogeneous alloy possessing the necessary mean of these properties to render it suitable for many important purposes, among others, that of the special object to be attained, to meet the requirements for an unalterable standard metal, for which it is peculiarly adapted.

In the manufacture of the prototype meters and the geodesique rules (each four meters in length) ordered from my firm by the Comité Internationale des Poids et Mesures, the Association Géodésique Internationale, and the French Minister of War, I proceeded in the following manner with the platinum and iridium prepared as described above:

Operating upon a charge of 450 ounces of platinum and 53 ounces of iridium, I commenced by melting these metals together and casting into an ingot of suitable shape, which I then cut into small pieces with hydraulic machinery. After remelting and retaining in a molten condition under a powerful blast of oxygen and common gas for a considerable time, I recast and forged at an intense white heat under a steam hammer, the highly polished surfaces of which were cleaned and polished after each series of blows; when sufficiently reduced, it was passed through bright polished steel rollers, cut into narrow strips, and again slowly melted in a properly shaped mould, in which it was allowed to cool. I thus obtained a mass of suitable shape for forging, perfectly solid, homogeneous, free from fissures or air holes, and with a bright and clean surface at bottom and sides as at top. At the first forging a bar was obtained 35 centims. long, 7·5 wide, 2·5 thick, which weighed:

In air	15·105 grms.
In water at 70° F	14·405 "
Showing a density at zero of	21·522 "

A third of the bar was cut off, and the larger portion again forged to a length of 95 centims., width, 2·5, thickness, 2·0, which weighed:

In air	10·814 grms.
In water at 60° F	10·315 "
Showing a density at zero of	21·648 "

This was then passed through highly polished rolls until of a length of 4,080 centims., 21 millims. in width, and 5 millims. thick, to which a perfectly rectangular form was subsequently given by drawing it through a series of plates, and thus prepared, the rule was in a condition to receive the beautiful polish of which this alloy is susceptible.

After passing it through each hole, the metal was annealed by means of a jet of gas and oxygen to a heat just below melting point, and each time throughout after forging, rolling, and drawing, was exposed to the action of melted borax, and boiled in concentrated hydrochloric acid to remove any possible trace of adherent iron or other impurity.

A piece cut from the end, and presented to the French Academy of Sciences, gave the following results:

Weight in air	116·898 grms.
" water	111·469 "
Showing a density of	21·516 "

thus proving that the necessary processes of annealing at a high temperature had caused it sensibly to resume its original density.

The analysis gave:

	I.	II.
Platinum	89·40	89·42
Iridium	10·16	10·22
Rhodium	0·18	0·16
Ruthenium	0·10	0·10
Iron	0·06	0·06
	99·90	99·96

From which is deduced:

	Proportion.	Density at zero.	Volume.
Iridio-platinum, at 10 p. c.	99·33	21·575	4·603
Iridium, in excess	0·23	22·380	0·010
Rhodium	0·18	12·000	0·015
Ruthenium	0·10	12·261	0·008
Iron	0·06	7·700	0·008
	99·90		4·644

Density at zero, calculated after No. 1 analysis, 21·510
" " " " No. 2 " 21·515

thus coinciding perfectly with the practical results obtained.

Messrs. Leon Brunner Brothers, of Paris, who had submitted this material of the geodesique rule to a great number of mechanical experiments, communicated the result of their observations to M. H. Sainte-Claire Deville, thus:

"PARIS, 27 Aout, 1878.

"MONSIEUR:

"La division de la règle géodésique que nous faisons pour l'Association Géodésique Internationale, est terminée depuis quelques jours.

"Nous avons pensé que vous ne seriez pas mécontent d'apprendre que cette operation à parfaitement réussi, et que c'est au métal que nous attribuons la facilité avec laquelle nous avons pu l'exécuter.

"Le platine iridié de M. Matthey est incontestablement supérieur au platine ordinaire pour la confection des règles divisées. Il est exempt de ces pailles qu'on rencontre toujours dans ce dernier, et se laisse polir au charbon. On peut, sans danger, enlever les rébarbes des traits et les conserver très beaux. Le platine ordinaire ne peut-être poli qu'au papier à émeré, et l'on est toujours exposé à gâter la division quand on procède à l'ébarbage. C'est là un inconvénient très-grave.

"Nous ne pouvons que vous remercier, Monsieur, d'avoir mis à notre disposition un métal qui modifie singulièrement les difficultés qu'on rencontre dans la fabrication d'une règle géodésique, et nous vous prions de recevoir l'assurance de nos sentiments les plus distingues.

"BRUNNER FRERES.

In the year 1876 the suggestion was made to supersede the rectangular form by a tubular one, and I was requested to produce one of the following dimensions: Length, 1,002 centims.; exterior diameter, 37 millims.; interior diameter, 35 millims.; with rounded ends, one having an extension of small tube 4 millims. exterior diameter, 2 millims. interior diameter, 40 millims. long, which I did by the system of tube making with autogenous joints, adopted by me with excellent results for the last twenty years, employing for the purpose an alloy prepared as above described. These proved to be so satisfactory, that I have since made others, both round and square, of various dimensions, as lately shown at the Paris Exhibition.

Iridio-platinum alloy has now been proved to possess the following among many advantages for standard rules and weights:

It is almost indestructible, has extreme rigidity, especially in the tube form, and a most beautifully polished surface can be obtained upon it; its coefficient of elasticity is very great, while for standard weights its high density is a valuable quality, and for these I should indeed recommend an alloy of not less than 20 per cent. of iridium. I lately made, at the request of M. H. Sainte-Claire Deville, a cylinder 40 millims. by 40 millims. of such an alloy, which showed by analysis the following proportions:

Platinum	80·6660
Iridium	19·0786
Rhodium	0·1220
Ruthenium	0·0460
Iron	0·0980
	100·0046

and gave the density of 21·614.

With such a high density its coefficient of elasticity is 22·200000, one of the highest known, while its malleability and ductility are almost without limit.

The volume of the kilogramme thus prepared is only 46·266 c.c., it displaces 2·267 c.c. less than the kilogramme of the archives of France, and on this account, as on many others, is, of course, preferable.

The results I have arrived at in preparing alloys of higher grades, viz., 25, 30, 40, and 50 per cent. of iridium, are as follows:

The alloy of 20 per cent. iridium is, as I have stated already, malleable and ductile.

25 per cent. can, only with great difficulty and waste, be worked into sheet and wire when heated at a low temperature; 30 per cent. and 40 per cent., with great difficulty only, at a temperature little less than melting point, being brittle when cold, but with a grain of great beauty and fineness.

50 per cent. I have as yet failed to work up into forms other than castings, beyond what I can effect by pressure when in a semi-fused condition.

The general results of my work on this alloy would lead me, therefore, to make the following recommendations:

For the manufacture of standard rules, to use an alloy of not less than 85 per cent. platinum and 15 per cent. iridium, adopting the tubular form.

For the standard weights, to use an alloy of not less than 80 per cent. platinum and 20 per cent. iridium, adopting the form now generally made.

Finally, following the expression of the great French chemist, M. Dumas, I hope by these labors "d'avoir enriché l'outillage scientifique d'un alliage doué des propriétés précieuse."

BRIEF HISTORY OF BESSEMER STEEL.

By Mr. BESSEMER.

AT the recent meeting of the Iron and Steel Institute, Mr. Bessemer gave the meeting a very interesting sketch of the history of Bessemer steel, and especially of Bessemer "mild steel," from the time of his great invention down to the present. He said it was just twenty years since he stood in the same place to read a paper before the Institute of Civil Engineers on the same question. He referred to the disastrous results which succeeded the first announcement of his invention at Cheltenham, and to the two and a half or three years' labor he had to undergo before he could come before the world with a practical mode of carrying out his principle successfully. "He had grasped the great fact, though he had not grasped the details." When he had completed the details, Mr. Bessemer read the paper of twenty years ago, to which he referred, before the Institute of Civil Engineers, who awarded him the Telford Gold Medal for the communication.

Mr. Bessemer next produced some most interesting samples which had figured on that occasion, and referred to them as follows:

Iron was the first object he sought to obtain before venturing to make steel by his process. The first sample, now shown, was a little bar of iron 3 in. square, which was bent cold, and which was considered not a bad sample of cold bending. The second sample to which he would call attention was a little gun, a small and modest production, but one that had its peculiarities. It was a gun made of malleable iron without weld or joint. That it was made of malleable iron he was desirous to ascertain without question, and, in March, he requested Mr. Riley to see it put in the lathe and a small sample turned off, and then to take the sample and analyze it. The result was as follows:

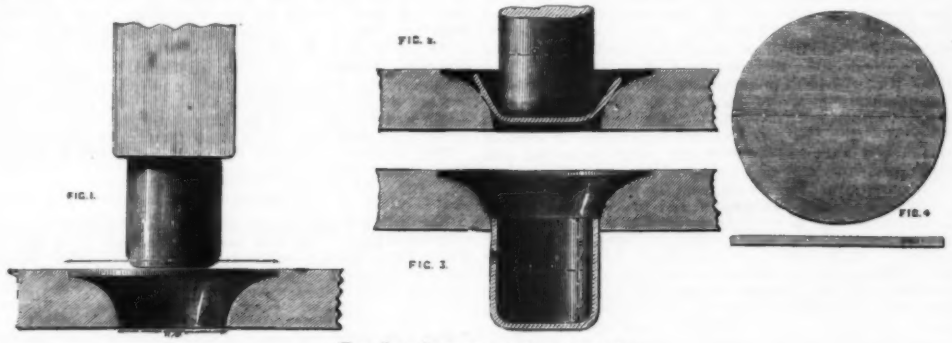
Carbon	·0014
Silicon	·004
Sulphur	·053
Phosphorus	·049
Manganese	nil.
Copper	minute trace.

Mr. Riley ascertained the quantity of iron by two analyses, and the quantity was in the—

1st.—Iron	99·893
2d.—Iron	99·787

Taking the average of these two results, it would be seen that the metal of the gun contained 99·84 per cent. of pure iron; that was perhaps as near to pure iron as could be got. That gun was made in 1858—21 years ago. It was shown in that hall to the superintendent of the gun factories at Woolwich; and, upon the strength of it, certain cylinders were made of malleable iron and mild steel. He now exhibited a mild steel cylinder of 5 in. bore and 1¾ in. in thickness of metal, simply cast, and crushed flat under the steam hammer while cold. He also produced a very interesting sample which he hoped would interest those present as a reminiscence of what had been done before. It would be remembered that the vessel first used by him for the converting process was a fixed upright cylinder. This form of converter had been adopted in Sweden, and into it they ran metal direct from the blast furnace; that metal was never made into pig, but was blown and made into ingots in 9 minutes. One of those ingots was brought over to England, and was rolled into a circular saw plate of 5 ft. in diameter. This was the first Bessemer steel ingot ever rolled into a plate in this country; the ingot was unhammered, and was produced without the use of ferro-manganese, spiegeleisen,

or recarburation. It was interesting to him, as the result of the first intimation of his process given to the world, through the British Association, at Cheltenham. He had also a remarkable sample of the further practical working of this process very soon after the erection of his steel works at Sheffield, 20 years ago. Mr. Parkes, of Birmingham, had invented a system of producing copper tubes by pressing a round disk through a hole by a plunger, thus producing a kind of cup, which was subsequently extended by drawing in dies to a tube with a closed end. At his (Mr. Bessemer's) works at Sheffield, Mr. Parkes said he could do the same with steel as with copper, although he was obliged to use the best copper to do it. He (Mr. Bessemer) then thought differently, and said, "It is utterly impossible that so rigid a material as steel could be so treated." But Mr. Parkes was so serious and earnest, that he (Mr. Bessemer) was induced to go the same evening by train to Birmingham to try it, taking with him three disks of his steel. It happened that at that time his firm were executing an order for locomotive tube plates for the Lancashire and Yorkshire Railway, and one of the disks taken to Birmingham was a piece 27 in. in diameter, and ¾ in. thick, cut from the end of the plates intended for these tube plates. At Mr. Parkes' works this disk was placed over a die with a trumpet-shaped mouth (Fig. 1) and subjected to the action of a plunger. When it had been forced into a cup shape (Fig. 2), Mr. Parkes said they must anneal it, and this was accordingly done, and the steel cup allowed to get perfectly cold. When it was cold it was again put on the die, and a second thrust of the plunger forced it completely through, producing the vessel exhibited (Fig. 3) without the slightest injury being done to the metal. Thus the circumference of a plate 27 in. in diameter had been reduced to a circle of 11 inches. He might



FIGS. 1 TO 4.—STEEL PLATE TREATED COLD.

FIG. 5.—BESSEMER STEEL RAIL, TWISTED COLD.

FIG. 6.—4-IN. SQUARE BAR OF BESSEMER STEEL TWISTED HOT.

BESSEMER STEEL EXHIBITED AT THE IRON AND STEEL INSTITUTE.

driving the rolls. He had carefully measured this sample, and he had found that in a part measuring 6 ft. along the center of the web, the flanges measured 8 ft. 1 in., they having thus been extended 2 ft. 1 in. during the process of twisting. Another sample exhibited was a 4 in. square bar, which had been twisted hot until the angles of the square formed a kind of four-threaded screw of a pitch varying from ⅝ in. to as little as ¼ in. (Fig. 6). He also showed some curious examples of Bessemer steel in another form in which it had come extensively into use. One was a small vase of complicated form, which had been produced cold from a thin plate, 11 in. in diameter, this plate having been subjected to the "spinning" process largely used in Birmingham for the production of certain articles. He also presented to them a jelly mould which was interesting, not from any elegance of design, but from the fact that it had been raised from a flat plate by hammering cold, and thus showed the power of the material to resist such treatment. He had been troubling them with what had been done for so long a period, that his remarks would appear to have rather a historical than a practical interest, but he wished to show that, although we had advanced in some respects in this manufacture, we still used precisely the same apparatus and the same mode of treatment as was employed in the production of these old samples twenty years ago, the toughness and malleability of which has never been exceeded. We now came to the paper which had been read by Mr. Barnaby, and in doing so he did not feel disposed to make a comparison between the two classes of steel therein referred to. No one admired or respected all the talents of the promoter of the Siemens process more than he did himself. All that he had to say was, let those who preferred the one use it; and those who preferred the other, let them use that. There was, however, one remark he wished to make in reference to Mr. Barnaby's paper. Mr. Barnaby told them that the present was the veritable beginning of a great and inevitable change. He believed in the veritable change, but he did not believe in the "veritable beginning." He flattered himself that he had a little to do with the beginning himself, and that was many years ago. He would tell them what was done twenty years ago. He had a list of steel ships which had been presented to him by the chief surveyor of Lloyd's Registers.

BESSEMER STEEL IN SHIPBUILDING.

In the early days of the Bessemer process he was anxious that steel should be used in shipbuilding; and knowing that it had been successfully used in boiler making, he thought it would be a good thing to have it used in shipbuilding to a large extent. He, therefore, applied himself to securing the introduction of steel for shipbuilding purposes, and at length an enterprising firm took up the matter and built two stern wheel barges of steel produced at his works at Sheffield. This was in 1863. The firm were so pleased with the behavior of the steel during the construction of these barges that they persuaded customers of theirs—the Hamboro' Steam Packet Company—to have a paddle steamer of 377 tons built of this material, and this vessel, the Cuxhaven, was constructed in 1864. The Clytemnestra, a sailing ship of 1,251 tons, and the Altcar, a sailing ship of 1,283 tons, were also built of steel in 1864. Next year, in 1865, six vessels of an aggregate tonnage of 5,342 tons, were built of Bessemer steel, viz., the Isabel, a paddle steamer of 1,095 tons; the Curlew, a paddle steamer of 409 tons; the Plover, a paddle steamer of 410 tons; the Sandan, a sailing ship of 184 tons; the Midland, a paddle steamer of 1,622 tons; and the Great Northern, a paddle steamer of 1,622 tons. At this point a hitch occurred in the use of steel for shipbuilding. The firm who had taken the matter up became involved in some financial difficulties, and the two vessels of over 1,600 tons last mentioned, which were in frame and partly plated, ran a risk of not been completed. Knowing the important results which might be expected to result from the employment of steel in shipbuilding, he was induced to supply funds for the completion of these vessels, and he put down £10,000 for that purpose. The vessels were finished, but the firm who built them had become too deeply involved, and their yard had to be closed. This caused a gap in the use of steel for ships, and next we came to two tugboats, 97 and 67 tons, built in 1871–72, while next was the Isabella paddle steamer, of 1,118 tons, built in 1877, of Bessemer steel made at Crewe; this vessel has its plates, angles, beams, and rivets, all of steel, and is one of those splendid Holyhead boats. These last mentioned are the "three small vessels" referred to in Mr. Barnaby's paper. Next in the list came nineteen barges built of Bessemer steel; then the Hermod, sailing ship, 743 tons, built in 1878; next a light paddle wheel steamer for the Irrawaddy Flotilla Company; then the Lanilies, the Light of the River, the Dahabiall, the Lynx, the Fox, the Owl, the Bat, the Colonel Lamb, the Wasp, the Hornet, the Rounce, the Georgia Bell, the Widgeon, the Snipe, and the Ruby. Here then we have a list of ten ships built of steel, the makers' names not registered, then nineteen barges of Bessemer steel, and thirty-two other well-authenticated ships built of Bessemer steel. This list was, as he had said, kindly made out for him by the chief surveyor of Lloyd's Registers, who, however, stated that he is of opinion that the foregoing does not include the whole of the ships built of Bessemer steel in this country. There were also eight steel ships of Siemens-Martin steel built in 1878; and seventeen Bessemer steel ships in the same year, and not eleven, as stated by Mr. Barnaby. As to those difficulties that had been referred to as arising in shipbuilding during the last sixteen years, he thought it extraordinary that out of the immense number of steam boilers—and he believed over a thousand had passed through the hands of Mr. Adamson, and over a thousand locomotives through the hands of Mr. Webb—they had not been met with such difficulties either in the boilers or the engines.

PLATINUM AND IRIDIUM.

A PAPER was recently read by Mr. Matthey—of the firm of Messrs. Johnson, Matthey & Co., the well-known metallurgists—before the Royal Society, giving a detailed account of the preparation and purification of platinum, iridium, and the allied metals.

Mr. Matthey finds that to obtain pure platinum is an operation of extreme delicacy, and he begins by fusing ordinary commercial platinum with metallic lead, and afterward dissolving out by dilute nitric acid as much of the lead as possible till the platinum lies in a state of fine powder at the bottom of the vessel mixed with some little of the lead and shining crystalline particles of iridium. Weak *aqua regia* is used to dissolve the platinum and lead, and the latter is thrown down by sulphuric acid. The yellow double salt is thrown down by chloride of ammonium and sodium, heated to 80° C., and allowed to stand for some days. The precipitate is next washed with solution of chloride of ammonium, and then with weak hydrochloric acid. If rhodium still remain, as is likely, it is removed by reducing the precipitate to spongy platinum by heating to dull redness in a platinum crucible the last-named precipitate mixed with bisulphate of potash and a small quantity of bisulphate of ammonium. This elaborate process enables platinum to be obtained free from rhodium, etc., and, indeed, in a state of absolute purity.

Mr. Matthey's instructions for purifying iridium are quite as elaborate, but he has not attempted to make it absolutely free from platinum, seeing that his process is for the purpose of getting an ultimate alloy of the two metals. Similarly, for photographic purposes, the admixture of platinum—seeing that iridium is generally used in conjunction—would not be of any material hindrance. He obtains the finest iridium capable of being purchased in the ordinary way and fuses it with lead, dissolves the latter out with nitric acid, and, after treating the residue with powerful digestion with *aqua regia*, obtains a crystalline mass. Rhodium is expelled by mixing the mass with bisulphate of potash and raising to a high temperature. The iridium so far purified is melted in a gold crucible with caustic potash and niter, and the mixture treated with cold distilled water, then with water containing in solution a little potash and hypochlorite of soda, and again with distilled water. The blue powder thus obtained is mixed with a strong solution of hypochlorite, and, after standing awhile, gradually heated to boiling point. The last traces of ruthenium are removed by heating with niter and potash water and hypochlorite of soda and chlorine.

The result so far is oxide of iridium, which has next to be dissolved in *aqua regia*, evaporated to dryness and redissolved in water and filtered, dropped slowly into a concentrated solution of soda and hypochlorite of soda, and subjected to a current of chlorine gas. The blue oxide thus again obtained is washed and dried and subjected to the action of carbonic oxide and carbonic acid. The mass is then heated to redness with bisulphate of potash, then subjected to repeated washings with distilled water, followed by chlorine water, and then by hydrofluoric acid, which finally leaves iridium free from almost every trace of foreign matter but platinum.

We have given these details, not with the idea of their being copied by ardent photographic experimentalists, but with the purpose of showing how extremely difficult is the purification of these remarkable metals, and to give our readers some idea of the contents of a paper which, we are inclined to believe, will be looked upon as a classical monograph upon what used to be termed the "infusible metals."
—*Brit. Journ. of Photography.*

PREPARATION OF MALLEABLE NICKEL AND COBALT.

By TH. FLEITMANN.

HITHERTO it was impossible to render metallic nickel and cobalt sufficiently malleable or ductile to form it into sheets or wire, or to obtain from them dense homogeneous castings. The author thought that this might possibly be caused by the absorption of carbonic oxide gas during the melting. He therefore tried to remove this defect by the addition of magnesium, which is known to reduce carbonic oxide as well as carbonic acid, with separation of carbon. He was surprised to find that even one-eighth of one per cent. of magnesium was sufficient for this purpose. The resulting castings are most easily rolled or shaped when hot. Nickel retains its ductility even when cold; but cobalt becomes exceedingly hard, so that it may perhaps even be employed for cutting instruments. Both metals take a high polish and resist the action of the atmosphere. Cobalt is much more brilliant

and whiter than nickel, the contrary statement of the text-books published hitherto notwithstanding.

The author particularly instructs those who desire to try this process to introduce first a few pieces of charcoal into the crucible in order to remove any oxygen, and then to add the magnesium through a hole in the lid, otherwise a violent explosion might result.—*Ber. d. Deutsch. Chem. Ges.*

NAPHTHALENE ($C_{10}H_8$).

THIS hydrocarbon, known also as naphthalin and naphthaline, has been known to tar distillers for many years, but it is only lately that the attention of the latter has been seriously turned to it as a source of revenue. The writer, in an article on Naphthalene, in Watts' Chemical Dictionary, published in 1866 (Vol. IV., p. 16), ventured to state that "there is no doubt whatever that in a few years, perhaps in a few months, the difficulties in the way of utilizing naphthalene will be overcome." That this prediction has been fully verified will be obvious to all who have followed the history of this substance.

It was remarked that naphthalene vapor, "fortunately when it is in small quantity, and unfortunately when the amount is large, travels with the gas beyond the purifiers. In the one case it adds greatly to the illuminating power of the gas, and in the other is liable to produce obstructions in the main and service pipes, thus leading to serious inconveniences. It is, in fact, a characteristic of naphthalene to remain dissolved in gaseous and fluid hydrocarbons, and to settle out in a solid form, generally on a fall in temperature, but sometimes in a manner that cannot clearly be traced to variations in either temperature or pressure.

Naphthalene was discovered by Garden, in 1820, but its formula and atomic weight were first determined by Faraday, in 1826. A great number of the most eminent chemists, including Oppermann, Laurent, Dumas, Stas, Mitscherlich, Woskressensky, Marchand, and Erdmann, also analyzed it; but only Dumas and Stas, and Erdmann and Marchand, obtained numbers so accurate as Faraday. The chemist who, above all others, devoted himself to an elaborate study of the compounds and products of decomposition of naphthalene was Laurent, who worked at it, more or less constantly, for at least 20 years. In the course of his researches, he not only discovered a vast number of derivatives, but was also led, from their intimate study, to settle on a firm foundation, the important but at that time much combated law of substitutions. A valuable list of the papers published anterior to the year 1860 will be found in the English translation of Gmelin's "Handbook of Chemistry," Vol. XIV., p. 1. For the publications which have appeared on the subject since that time, the reader is referred to "Watts' Dict. Chem.," Vol. IV., and the supplement to that work.

Naphthalene is principally obtained from coal tar, but it is also produced from a great number of other organic substances when submitted to a high temperature. It is frequently formed when substances of lower atomic weight are passed through red hot tubes. Thus, ethylene, treated in the manner last described, yields marsh gas and tarry substances containing naphthalene. According to Magnus, when a white heat is employed, no naphthalene is produced, the ethylene being decomposed into carbon, which is deposited in the tube, and hydrogen, which is not accompanied by any tarry bodies.

Berthelot has also obtained naphthalene by passing alcohol, ether, petroleum, and essential oils through a red-hot porcelain tube. The same chemist has obtained naphthalene by passing the vapor of acetic acid through a red-hot porcelain tube containing fragments of pumice-stone. In this case it appears to be accompanied by phenol, inasmuch as a brown oil comes over, which, when treated with nitric acid, yields picric acid (trinitro-phenic acid).

According to Fremy, naphthalene is produced when camphor is passed over strongly ignited lime, and condenses in the receiver in fine and perfectly pure crystals.

Connel found naphthalene among the products obtained when fat oils are used for the preparation of illuminating gas, and Pelletier and Walter obtained it from resin when fused and run into red-hot cylinders.

Berthelot has found that when toluene is passed through a red-hot tube it yields naphthalene, benzene, and hydrogen. Xylene, treated in a similar manner, yields naphthalene and toluene; and cumene yields naphthalene and xylene. In each case free hydrogen is given off. He also found that naphthalene is formed when a mixture of the vapor of benzene, cinnamene, anthracene, or chrysene was passed with ethylene through a red-hot tube. But we have seen that, according to Magnus, ethylene alone does the same thing.

According to Warren and Storer, naphthalene may be obtained by the refrigeration of that portion of Rangoon petroleum which boils between 208° and 209° C. = 406° and 408° Fahr.

Naphthalene may also be obtained in many other reactions, but as the details are chiefly interesting to scientific chemists, the reader who requires more information upon this branch of the subject is referred to the works before mentioned, and especially the English, French, and German scientific journals.

Naphthalene is chiefly obtained during the distillation of the creosote or pitch oils—the heavy oils of the French tar distillers. Supposing a charge of 7,000 gallons of boiled tar to be distilled in the manner we have described in the "Scotch System," the first 200 gallons will be comparatively free from naphthalene, and they are, as we have said, to be used up in the naphtha house. The distillate after this point will be found to contain naphthalene in gradually increasing quantities. The tanks in which the heavy or creosote oils are stored will be found after long standing, especially in cold weather, to contain large quantities of crude naphthalene. The writer has sometimes obtained more than a ton at a time on running off the oil from two or three large tanks.

As long as the demand is not greater than it is at the present time, the deposits in the creosote oil reservoirs will probably be a sufficient source of naphthalene for commercial purposes. Some heavy oils which appear to have ceased to deposit any more naphthalene may often be made to yield a large proportion of their bulk of the crude substance by powerful refrigeration. Sometimes mere distillation will cause separation; but a treatment with a moderate quantity of sulphuric acid, followed, after removal of the "sludge," and washing, first with water, and then with an alkaline solution, by a distillation, will generally enable a large quantity of naphthalene to be obtained on repose of the distillate. It is the writer's impression that larger quantities of naphthalene are obtained if the treatment with alkaline solutions be either omitted, or not carried for enough to entirely neutralize the acid in the naphtha. This mode of proceeding, has, however, its inconveniences.

The crude naphthalene obtained as above is exceedingly impure, being contaminated with a large quantity of oil. It may be drained in bags or in filter tubes lined with coarse unbleached calico. The oils which drain away will deposit much more naphthalene on standing, especially in cold weather. A little solid naphthalene thrown in will sometimes assist in setting up the formation of a deposit.

As the demand for naphthalene increases, and the price consequently rises, artificial refrigeration will have to be resorted to in its preparation on the large scale.

The crude substance has a very offensive odor. This is due partly to the presence of phenol and other strongly smelling bodies, especially leucoline and homologous organic bases of high boiling point. Washing with alkaline solutions will remove the former, and acids the latter. When the greater portion of the oily impurities have drained away, the naphthalene may be "whirled" in a centrifugal machine, or a filter press may be used instead of draining on bags. The naphthalene is then to be distilled. This may be performed in a still having a large exit pipe, which must be kept hot enough to prevent its being choked up. As the substance melts at 79° C. = 174° F., a temperature of 80° C. = 176° F. will be sufficient for the purpose. The pipe should be so arranged that a clearing rod can be passed if necessary into the still. This necessity can, however, only arise in the event of the heating of the exit pipe having been neglected. The clearing rod should have a crescent shaped scraper attached to it, to enable any of the condensed hydrocarbon to be removed at once. It is obvious that no worm must be used in the distillation, and that constant attention must be given to it, to prevent stopping up of the exit tube, or, if it should take place, to allow of its being cleared instantly. It is proper, also, to have a safety valve on the still. This latter should be so arranged that it cannot cool down below the melting point of naphthalene, as, in that case, the valve might become cemented into its seat with the condensed hydrocarbon. The distillate may very conveniently be condensed in cylindrical or square iron tanks, connected by a short wide tube with the head of the still.

When it is wished to prepare very white and pure crystals of naphthalene, the writer proceeds as follows. A large shallow evaporating basin—a milk pan does very well—is to be charged with a few pounds of the substance. A sheet of coarse muslin is then to be stretched over the edges, and pasted down. Another dish or pan of the same size is then to be inverted over the first one, and the two are to be luted together with the ordinary almond and linseed meal luting. A small hole should be made in the luting to allow the escape of expanded air. The apparatus so prepared is to be placed on a sand bath, and moderately heated for some hours. The fire should then be withdrawn, and the whole allowed to cool very slowly. When quite cold, the upper dish is to be removed; and, if the proper temperature has been employed, fine crystals will be found on the muslin. On removing the latter, a large quantity more will generally be found lying on the fused cake. They can be removed with a brush or feather. When one crop of crystals has been obtained, it is only necessary to replace the muslin, and proceed as before. When slowly sublimed, naphthalene forms such an extremely light bulky mass, that sometimes a quarter of a gramme will fill a liter flask. ("Gmelin's Handbook," XIV. v.)

When perfectly pure, naphthalene has by no means an unpleasant odor, and its smell in this state has even been compared by Garden to the narcissus (*loc. cit.*, p. 6).

Naphthalene fuses at 79° C. = 174° Fahr., and boils, according to Kopp, at 218° C. = 424° Fahr.; the barometric pressure being 760 millimeters = 29·92 inches. Its specific gravity at 15° C. = 59° Fahr., is, according to Vohl, 1·15173. Its vapor density, as determined by Natanson, was 4·46; theory requiring 4·43. Naphthalene distills pretty readily in the vapor of water, and, consequently, accompanies coal naphtha when distilled in a current of steam.

The various derivatives of naphthalene are so numerous that merely to give a short sketch of them would require more space than has been given to the whole subject of "residual products."

Its property of increasing the illuminating power of gas has been more than once alluded to in this Journal and in the "Treatise."

The reader desirous of further information on this subject is referred to the patent of Livesey and Kidd, Jan. 18, 1878, No. 244, and the memorandum of alteration and disclaimer, filed Nov. 1, 1878.

Naphthalene may be converted into a base or alkaloid by steps completely analogous to those by which benzene is converted into aniline—namely, by first preparing a mono-nitro compound, and reducing the latter by means of ferrous acetate.—*Journal of Gas Lighting.*

HOULGRAVE'S SIMPLE PROCESS FOR PREPARING GELATINE EMULSION.

IN a recent letter to an amateur photographer in this country, Mr. Houlgrave, of Liverpool, England, gives further details in respect to the preparation of his gelatine emulsion as follows.

"In the first place let me explain that I always prepare my emulsion and plates in the evening, so that the times for performing the various operations are calculated for this. I employ the following utensils: two German glass beakers, one holding about four ounces, the other about half that quantity; an eight ounce bottle with cork lined stopper (glass stoppers are apt to stick); a tin canister with loose fitting lid, large enough to hold the bottle; a flat porclain dish 7 in. by 5 in.; a tin tray about 1¼ inches deep, and a little larger than the dish; an earthenware vessel with cover holding from six to eight quarts; a Bunsen burner and small spirit lamp. I use Nelson's No. 1 photographic gelatine, as it does not require long soaking in cold water before it is ready to dissolve.

It is quite essential that the bromide salts should be in excess, and for this reason I always test my materials before using them. Should this, however, be inconvenient, I should advise the use of rather less silver than I have prescribed in my formula; say 45 grs. instead of 46 grs. In the larger beaker dissolved 26 grs. bromide ammonium in 7 drachms of water and 1 drachm of beer, and then add 10 grs. of gelatine, pressing it under the fluid with a glass rod. Place the remaining 16 grs. of gelatine in a separate vessel, and fill up with cold water. In the small beaker dissolve 45 grs. nitrate silver in 4 drachms of distilled water, and add three or four drops of dilute nitric acid (this is not necessary, but it helps greatly to keep the shadows clear).

The beer above mentioned is prepared by mixing 3 oz. of ordinary bitter ale with one ounce of alcohol. This lasts a long time and is always ready to use. The nitric acid solution is prepared by mixing 1 drachm of strong nitric acid with one ounce of water.

Arrange the tin tray on any suitable support over the Bunsen burner; pour on water until it is about ½ an inch deep; place in the tray the eight ounce bottle and the two beakers, and light the gas. Let the temperature rise to about 100° Fahr., and then lower the flame. As soon as the gelatine in the beaker containing the ammonium and beer is completely dissolved, pour into the same in one continuous stream the silver solution, at the same time stirring briskly with the glass rod. Transfer the emulsion just made to the eight ounce bottle, rinse both beakers with a drachm of water, pouring it from one to the other, and finally into the bottle, and then give the emulsion a thoroughly good shaking. Next place the eight ounce bottle containing the emulsion into the tin canister, into which a little hot water has been previously poured, loosen the bottle cork, and gradually raise the water in the canister to a boil over the gas burner (this should not require more than 5 minutes). Remove the light when the temperature of the emulsion has sunk to 100° Fahr., add the remainder of the gelatine, having first drained off as much of the water as possible, shake gently, and keep the emulsion at a moderate heat for a short time longer, in order to allow time for any froth which may have been formed to subside; then pour the emulsion into the flat porcelain dish to set, place this on any level surface perfectly excluded from light, and leave it till the next morning. Then fill the earthenware vessel with cold water, and plunge into the same the flat porcelain dish containing the emulsion and cover up, letting it remain in a cool place till any convenient time in the evening, changing the water once an hour or so before using the emulsion.

When ready to coat the plates, take a strip of tin or brass half an inch wide and bend it into the form of the letter V; place it in the tin tray; fill the latter with water enough to cover the brass strip, and place in the tin tray the porcelain dish containing the emulsion; heat the water with lamp until the temperature is not less than 100° Fahr.; now drop in 10 drops of the chrome-alum and glycerine mixture, filter the emulsion through a piece of fine sponge into a beaker, having a mark at two ounces, and should the quantity fall short of this, make up with warm water. Next coat the plates and place them on a perfectly level shelf, and not disturb them until quite dry.

The beaker containing the emulsion should be kept in warm water while coating the plates.

DEVELOPMENT.

The ordinary well known alkaline development succeeds with these plates very well, and for portraits it is the one which I use; but for landscapes I very much prefer the following, for which the below mentioned solutions will be required.

No. 1.

Put 4 oz. good carbonate of ammonium into a pint bottle and fill up with water (this will take a day or more to dissolve).

No. 2.

Pyrogallic acid, 60 grains; alcohol, one ounce.

No 3.

Strong liquor ammonia, one drachm; bromide ammonia, 5 grains; water, one ounce.

No. 4.

Alcohol, 2 ounces; water, one pint. Pour sufficient of No. 4 into a dish, plunge the plate to be developed into it, and let it remain there a minute or longer. Then mix the developer in the following proportions:

One drachm, No. 1; two drachms, No. 4; six drops, No. 2. Pour this quickly on and off the plate a few times, and then add more pyrogallic acid solution. This should bring out the image in all its details; if it does not do so, drop in from 5 to 10 drops liquor ammonia (No. 3). This will probably be sufficient; if not, rinse the plate with a small quantity of alcohol and mix a fresh developer, viz., pyrogallic acid solution, 5 drops; liquor ammonia, two drops; dilute alcohol, one drachm. Pour this on and off the plate, and add more liquor ammonia if required. Fix in moderately strong hyposulphite of soda (hypo, 4 ounces; water, 1 pint).

Plates prepared and developed in this way are slow, the exposure with an ordinary landscape lens being from 10 to 30 seconds; they are, however, extremely easy to prepare, are almost absolutely certain, and give the best results I have been able to obtain by the gelatine process.

H. HOULGRAVE.

Formula referred to in above was given in SUPPLEMENT No. 174, as follows:

Gelatine	26 grains.
Bromide of ammonium	26 "
Nitrate of silver	46 "
Water	2 ounces.

CHROME ALUM MIXTURE.

Dissolve 20 grains of chrome alum in one ounce of water, and then add half an ounce of glycerine.

ON THE VOLUMES OF LIQUIDS AT THEIR BOILING POINTS OBTAINABLE FROM UNIT VOLUMES OF THEIR GASES.

By DR. W. RAMSAY.

KOPP, in 1855, pointed out that the specific gravities of organic compounds show a certain regularity with regard to each other. If the molecular weights of various compounds be divided by their respective specific gravities at their boiling points, a series of numbers is obtained, which Kopp ultimately named specific volumes.

Kopp's method of determining the volume of a liquid at its boiling point (the only point at which volumes are comparable, for at that point the vapor tensions of all liquids are equal) was to ascertain the boiling point with great accuracy, to determine the specific gravity of some known temperature, and calculate the volume required by means of the coefficient of expansion. This process involves the use of complicated and expensive apparatus, and necessitates laborious calculation.

Before describing the apparatus used by himself, the author discusses the precise conceptions involved in the expressions used by Kopp, etc., "atomic volume," "molecular volume," and "specific volume." Specific volume, as used by Kopp =

$$\frac{\text{molecular weight}}{\text{specific gravity.}}$$

By molecular weight is meant the specific gravity of the gas, hydrogen at 0° being equal to 1; specific gravity, water =1;

so that two scales are employed, viz., one based on H_2 as unity, and one based on water. The number obtained from the above equation, therefore, does not give the relation between the volumes and weights of liquids at their boiling points and that of the gases obtainable from those liquids. To obtain this relation, the number representing the specific gravity of the liquid must be multiplied by the number which represents the relation between the specific gravity of water and that of hydrogen, *i. e.*, 22,326. By reversing Kopp's process, *i. e.*, by dividing the sp. gr. of the boiling liquid by that of the gas, the amount of gas obtainable from unit volume of the liquid is calculated. Thus specific volume of liquid hydrogen $=5{\cdot}5$, and its sp. gr. is $\frac{1}{5{\cdot}5}$, or $0{\cdot}1818$, and $0{\cdot}1818\times22326=4059{\cdot}2$, the sp. gr. of liquid hydrogen (hydrogen gas $=1$). By dividing the sp. gr. of gaseous hydrogen by that of liquid hydrogen, or $\frac{1}{5059{\cdot}2}$, we get $0{\cdot}00024635$ as the volume of liquid obtainable from 1 volume of gas, or 2·46 from 10,000 vols. of gas. This number (2·46) the author proposes to call "ebullition volume." Kopp's numbers give the amounts of boiling liquids obtainable from 22,326 vols. of gas at 0°.

The apparatus used by the author consists of a thin glass bulb of about 10 c.c. capacity, in shape like a lemon; its upper end is terminated by a hooked capillary tube, and its lower end is closed and furnished with a glass hook. The capacity is accurately determined by filling with boiled distilled water and weighing. To determine the weight of a known volume of a liquid at its own boiling point, the bulb is filled with the liquid, and suspended by a platinum wire in a glass vessel resembling a large test tube, having a bulb blown about half an inch from the bottom. A small quantity of the liquid is placed in this glass flask, and the bulb suspended by a platinum wire from the cork which fits in the upper part of the flask. The liquid in the flask is caused to boil by a small Bunsen flame. The vapor heats the bulb, the liquid in it expands, and drops are expelled from the capillary tube.

As soon as the drops cease to fall, usually in about ten minutes, the bulb and its contents have assumed a temperature equal to the boiling point of the liquid. The bulb is withdrawn, allowed to cool, and weighed. Various precautions must be taken with liquids which are very volatile or oxidizable. Allowance is carefully made for the expansion of the glass. The time required for one determination is about half an hour.

The author has made many determinations with a great variety of substances. His results, on the whole, agree very closely with those obtained by Kopp. The value of some of the elements seems to vary much. Thus oxygen has two values, 3·49 and 5·45; sulphur, 10·27 and 12·79. Nitrogen in amines is 2·3; in cyanogen compounds, 17; in bodies containing NO_2, 17·4 (Kopp). The author has determined the ebullition volume of some of the pyridine series of bases, *e. g.*, in picoline, value of N=4·08; in its isomeride aniline, N=2·11; in pyrrol, N=9·12. From its volume it appears to belong to the cyanogen group.

In conclusion, the author draws attention to the enormous differences between these values of N, and suggests a connection between values and the amounts of heat evolved in the formation of these substances.

ON A METHOD OF PRECIPITATING MANGANESE ENTIRELY AS DIOXIDE, AND ITS APPLICATION TO THE VOLUMETRIC DETERMINATION OF MANGANESE.

By J. PATTINSON.

MANY methods of determining manganese volumetrically have been suggested, but none have come into general use, owing principally to the difficulty of obtaining the whole of the manganese in a definite and uniform state of oxidation. The author has examined the methods suggested by Pereno and Lenssen, but did not succeed in obtaining regular results. Wright and Luff have also been unable to obtain pure manganese dioxide by any of the ordinary methods. After numerous experiments, the author found that the whole of the manganese in a solution of manganese chloride could invariably be precipitated in the condition of dioxide, if a certain amount of ferric chloride be present, by a sufficient excess of a solution of calcium hypochlorite or bromine water, adding, after heating the solution to from 140° to 160° F., an excess of calcium carbonate, and then well stirring the mixture. Without the ferric salt, the precipitation, as MnO_2, is imperfect. Zinc chloride may be substituted for ferric chloride, but neither aluminum nor barium chlorides have the same desirable effect.

The author recommends the following solutions, etc.:

The clear liquid obtained by decantation from a 1·5 per cent. solution of bleaching powder; light granular calcium carbonate, obtained by precipitating an excess of calcium chloride by sodium carbonate at 180° F.; a 1 per cent. solution of ferrous sulphate in dilute (1 in 4) sulphuric acid; standard solution of potassium dichromate equivalent to 1 part of iron in 100 of solution. The application of the process to manganiferous iron ores is as follows:

Ten grains of the ore, dried at 212°, are dissolved in a 20-oz. beaker in about 100 fluid grains of hydrochloric acid (sp. gr., 1·18). Calcium carbonate is then added until free acid is neutralized and the liquid turns slightly reddish. 6 or 7 drops of HCl are now added, and 1,000 grains of the bleaching powder solution, or 500 grains of saturated bromine water, and boiling water run in until the temperature is raised to 140° to 160° F.; 25 grains of calcium carbonate are added, and the whole well stirred. If the supernatant solution has a pink color, the permanganate is reduced by a few drops of alcohol. The precipitated oxides of iron and manganese are filtered off and washed. 1,000 grains of the acidified ferrous sulphate solution are carefully measured into the 20-oz. beaker already used, the filter with its washed contents added. A certain quantity of the ferrous sulphate is oxidized by the MnO_2; this quantity is estimated with the standard dichromate solution, when the quantity of MnO_2 can easily be calculated. The iron present must be at least equal in weight to the manganese during the precipitation, in order to insure the absence of lower oxides.

The author gives in detail the slight modifications necessary in the analysis of spiegeleisen, ferro-manganese steel, and manganese slags; also some analyses which prove the accuracy of the process.

ADULTERATION OF WAX.

By DR. MAX.

BEESWAX is often sophisticated to the extent of 33 to 50 per cent. with ceresine, a mixture of refined earth wax and carnauba wax. Pure beeswax has a higher specific gravity (0·94 to 0·97) than these ingredients or than the mixtures, which range from 0·876 to 0·937. Prof. v. Wagner recommends the sample to be placed in dilute alcohol of sp. gr. 0·945, and rejected as impure unless it floats.—*Dingler Polyt. Journal.*

ON THE DETERMINATION OF NITRIC ACID AS NITRIC OXIDE BY MEANS OF ITS ACTION ON MERCURY.

By MR. WARINGTON.

DURING the last two years the author has used this method to a considerable extent. It was first suggested by W. Crum, and has been much improved by Frankland. The author has in the main carried out the process as recommended by Thorp in Sutton's "Volumetric Analysis." He did not, however, expel any gas which might be liberated before shaking. In the presence of some kinds of organic matter a permanent froth was at some times produced. This could be destroyed either by the introduction of a little hot water through the stopcock, or by gently warming the liquid in the inclined tube by a small flame.

A considerable number of experiments are given as to the effect of chlorides on the accuracy of the results obtained in estimating nitrates, nitrites, and the nitric acid in soils. The author finds that the results are quite as satisfactory, even when chlorine is present in a quantity equal to eight times the equivalent of the nitrogen, and concludes that chlorides, except perhaps in extreme cases, are no hindrance to the accurate determination of nitric and nitrous acid by this method, and that it is unnecessary to remove them by previous treatment with sulphate of silver.

The author then investigated the influence of organic matter, and finds that organic matter, in quantities likely to be met with, affect the results but little; cane sugar, however, has a remarkable action in preventing the complete evolution of the nitric oxide. In some cases a considerable quantity of gas was evolved without shaking. This gas was found to be nitric oxide, the action taking place between the nitric acid and organic matter, instead of between nitric acid and mercury. It is obvious that a considerable error would be caused by expelling any gas liberated before shaking in such cases. Commercial glucose has a considerably less injurious effect than cane sugar. It is interesting to observe that chlorides, if present, seem to prevent to a great extent the injurious effect of cane sugar.

Thus a solution containing 20·8 parts of nitrogen gave by the process, after removing chlorides, 12·6 and 11·5, but with chlorides not removed, 18·5. In some cases the author has observed that the reaction is not completed in the shaking tube, but that bubble of gas continues to be evolved when the liquid was transferred to the measuring tube. The reason of this defective reaction was not discovered. The author draws the following conclusions:

That in the absence of organic matter, and with proper manipulation, the method is one of great accuracy, and is capable of determining extremely small quantities of nitrates and nitrites; the natural error of the process is a small one of deficiency; the presence of chlorides in moderate quantity is no hindrance; quantities of organic matter, small, in relation to the nitrates present, have little or no effect on the results; larger quantities, especially of cane sugar, may cause a considerable deficiency; this deficiency is reduced by the presence of chlorides, but is not entirely removed.

NEW REAGENT FOR CARBOLIC ACID.

ONE to two drops of the liquid should be placed in a porcelain capsule, with the addition of two or three drops of a solution of molybdic acid in ten parts of sulphuric acid. If carbolic acid is present, there is produced immediately a light yellow or yellowish brown color, which changes to a maroon, and, finally, to a purple. The solution should be very dilute.—*Polyt. Notizblatt.*

DETERMINATION OF NITRIC ACID CONTAINED IN COMMERCIAL LIME JUICE.

By F. DOTTO-SCRIBANI.

THE author takes 100 c.c., boils the liquid, and neutralizes exactly with baryta water. Citrate of barium is formed and precipitated, while barium nitrate remains in solution. The liquid is let cool, the citrate is separated from the nitrate by filtration, and the latter salt is decomposed with sulphuric acid The barium sulphate obtained is filtered, washed, etc., and weighed with the usual precautions, and on multiplying its weight, less the ash of the filter, by 0·4635, the quantity of nitric acid present in 100 c.c. of the juice is obtained.—*Gazzetta Chemica Italiana.*

ACTION OF MONO-CHLOR-ACETIC ACID UPON SULPHO-CYANIC ACID AND ITS SALTS.

By M. NENCKI.

ON heating a mixture of 1 mol. chlor-acetic acid, dissolved in double its weight of water, with 3 mols. ammonic sulphocyanate, the liquid obtained deposits crystals of a new compound, rhodanic acid, $C_3H_3NS_2O$, which crystallizes in tables and six-sided prisms of a fine yellow, scarcely soluble in cold water, but readily in alcohol, ether, and alkalies. It melts about 168° to 170°, with partial decomposition, yielding a brown-red liquid. Under the influence of feeble oxidizing agents it produces coloring matters. A red and a violet matter have thus been obtained which in acid solutions dye silk and wool, and in alkaline solutions produce a blue shade upon cotton.—*Journal f. Praktische Chemie.*

PROCESS FOR DISCOVERING THE EFFECTIVE QUANTITY OF TARTARIC ACID CONTAINED IN DREGS OF WINE.

By PROF. FRANCESCO DOTTO-SCRIBANI.

THIS process serves for determining the effective quantity of tartaric acid not merely in unadulterated but even in the dregs of plastered wines. 10 grms. of the dregs are reduced to a very fine powder and dried in the water bath, and then moistened and made into a paste with pure hydrochloric acid in a porcelain capsule, and allowed to stand for twenty-four hours. The mass is then lixiviated with boiling distilled water, the liquid is filtered, and this treatment is repeated with the residue upon the filter till the liquid passing through no longer reddens litmus paper. The filtrate is then boiled in a porcelain capsule, and while it is continually stirred with a glass spoon, milk of lime, obtained by levigation and passed through a strainer, is added little by little until the liquid begins to turn red litmus paper blue. The capsule is then allowed to cool, and the contents thrown upon a double filter which has been previously well washed, and the precipitate is then washed until on acidulating the washings with nitric acid and testing with nitrate of silver no turbidity is observed. The precipitate with the double filter is then dried in the water bath and weighed, having care first to detach the outer from the inner filter, and to place the former in the weight scale, and from its weight is deduced the effective quantity of tartaric acid, since 100 parts of calcium tartrate contain 57·69 parts of tartaric acid. This process is founded on the following principles: The acid tartrate of potassium and the tartrate of calcium are less soluble in boiling water than in such water acidulated with hydrochloric acid, with which the two salts produce chlorides of potassium and calcium, while tartaric acid is set free. The coloring matter of the dregs is insoluble in hydrochloric acid. Milk of lime has no action upon the chlorides, but transforms the tartaric acid into calcium tartrate.

A NEW METHOD OF PRODUCING A COATING OF MAGNETIC OXIDE ON IRON SURFACES.

By GEORGE R. TWEEDIE.

IT will be remembered that last May I had the pleasure of laying before the readers of the *Chemical News* a few details respecting Mr. George Bower's process for producing a coating of magnetic oxide of iron by the action of hot air.

A continuation of the experiments has led to the patenting by Mr. Bower of a second process of considerable interest.

It was ascertained, during the time the experiments with the air process were being carried out, that the magnetic oxide was formed by the oxygen of the air combining with the carbon of the iron and forming carbon dioxide, which, in presence of the heated iron, was split up according to the well known reaction:

$$4CO_2+Fe_3=Fe_3O_4+4CO.$$

This fact readily explained why the process was unsuitable for wrought iron or steel.

It was then resolved to carry out a further series of experiments bearing on this fact, and the best means of applying it practically. Pure carbon dioxide prepared in the usual way was first tried. A silvery coating of magnetic oxide was formed after an exposure of about seven hours at a dull red heat; the coating, however, was crystalline, and somewhat brittle, although very hard.

Very long and tedious sets of experiments were then carried out with mixtures of carbon dioxide and air, air and carbonic oxide, and varying exposures of the three together.

The following is the method of procedure now adopted, and which answers most satisfactorily:

The articles are first of all heated, and acted on for a certain period by the products of combustion, largely mixed with air from a peculiarly constructed furnace (designed by Mr. Anthony Bower) burning slack or small coal. In this way a coating of magnetic oxide is formed close to the surface of the iron, but this is often slightly covered with red oxide, Fe_2O_3. The admission of air to the furnace is then so arranged by a suitable apparatus, that a stream of carbonic oxide is passed over the articles for a short time, and the red oxide very speedily reduced to magnetic oxide,

$$3Fe_2O_3+CO=2Fe_3O_4+CO_2.$$

It is worthy of note that although the red oxide, before reduction to magnetic oxide, is very readily detached from the iron, after the reduction the Fe_3O_4 so formed is perfectly hard and homogeneous. From all appearances it would seem as though a kind of fusion took place, but at the same time it must be recollected that the temperature used (a red heat) is very low to favor such an action.

The oxide formed by this process has been tested very thoroughly, and withstands the ordinary oxidizing influences perfectly.

Mr. Bower has several contracts in hand which are to be dealt with by his processes, and will present opportunities for the practical testing of the two processes from a commercial point of view.—*Chemical News.*

NITRITE OF AMYL.

By DR. WM. H. GREEN.

THE author states that a very fair yield of nitrite of amyl may be obtained by the action of potassium nitrite and sulphuric acid on amylic alcohol, having a boiling point between 128° and 132° C. The potassium nitrite may be easily made by maintaining potassium nitrate for some time at a dull red heat. It is then heated with amylic alcohol in a flask on a water bath, and sulphuric acid, diluted with its volume of water, gradually added. Nitrite of amyl distills over regularly with some vapor of water. After washing the product with a solution of potassium carbonate, and drying it with solid potassium carbonate, it is distilled, and all that passes below 100° C. may be retained Perfectly pure nitrite of amyl boils at 96° C.—*Am. Journ. Pharm.*

"KERITE," a kind of artificial caoutchouc, is the invention of Mr. Day, of New York, and is made as follows: To produce 100 parts by weight of kerite, 27 parts of cotton oil, and 30 parts of oil tar are heated together in a caldron for several hours, at a temperature of about 150° C. After this has been done, 30 parts of linseed oil, 12 parts of sulphur, and 5 of ordinary wax or of solid paraffine are added. The whole is then heated for five or six hours, at a temperature under 150° C., to prevent carbonization. It is then allowed to cool, and is moulded into blocks convenient for future purposes. The price is about one-third of the natural caoutchouc. Mr. Day received honorable mention for kerite insulated telegraph core, exhibited at the Paris Exhibition.

CHEMICAL RECREATIONS.

By ALBERT B. PRESCOTT, M.D., Professor of Organic and Applied Chemistry, University of Michigan.

THE every-day operation of making a fire would be one of the most attractive and instructive of chemical experiments if only it were novel and were done with some thought of its significance. A child is always delighted with the opportunity of kindling a fire; apparently aware that the control of fire is a proud prerogative of human intelligence, representing man's mastery of natural forces. It is of decided interest to see an iron wire burn in a jar of oxygen on the lecture table, and an explanation is at once in demand, but wooden splinters burn in the air every day, with scarcely an explanation once in a lifetime. "Why do they burn?"

"Why, everybody knows that wood will burn, when it is set afire."

"What becomes of it after it burns?"

"Oh, it burns up; that is, all of it but the ashes and the smoke. Well, in chemistry there is a gas produced in the act of combustion, carbonic acid gas, that goes off in the air."

Quite as vague as this, it may be assumed, would be the first mental reply of very many well informed persons to an abrupt question about the nature of combustion; and there are combustions and combustions, oxidations and oxidations, going on before our eyes and under our fingers, but gaining no recognition from our absent minds. Now, whatever is presented to the attention as an experiment has the advantage of starting up questions as to why, and how, and what for, and if some of the chemical recreations here to be proposed should seem to resemble certain work-a-day operations of the prescription table, the dispensing counter and the surgeon's ward, they may be none the less serviceable to the purpose of entertainment and instruction. To illustrate various forms of oxidation it would be well to select some substance (1) possessing extreme oxidizing powers, (2) declaring its effects to the senses by decided signs, and (3) not too dangerous for pastime. As fulfilling these requirements reasonably well we will select

PERMANGANATE OF POTASSIUM.

The article (costing twelve to fifteen cents an ounce) comes in lustrous brown-black crystals, soluble in about sixteen parts of water. Dissolved in 114 parts of distilled water (64 grains to the pint), it constitutes the liquor potassii permanganatis, U. S. Ph., the B. Ph liquor being nearly of the same strength; when dissolved in about 50 parts of distilled water (9¼ grains to the fluid ounce) it constitutes Condy's disinfectant fluid; dissolved in water, free from organic matter, in proportions at the discretion of the maker, very weak solutions being most brilliant, it has been sold under the name of "ozonized water."

The brilliant purple color of this solution, most noticeable in solutions weak enough or in layers thin enough to be nearly transparent, and the sudden disappearance of this color under various influences, have given it the familiar name of "the chameleon fluid." The permanganate is a compound loaded to excess with oxygen, which it gives as super-active oxygen, or ozone, to any oxidizable substances, and when giving oxygen it loses color.

To find whether substances are liable to easy oxidation or not: Dissolve about two grains of the permanganate in a pint of water (free from organic matter), and use this as test liquid. If the substance to be tested is a solid, it should be dissolved in water, if a liquid, it should be miscible with water. Place a little of the solution to be tested in a glass tumbler or other glass vessel, and pour a thin stream of the purple solution into the center of the solution tested. If the mixture turns brown, while the purple vanishes on reaching it, add a little sulphuric or hydrochloric acid either to the purple test liquid or to the solution undergoing examination. But the chameleon fluid will not so long remain intact and of bright color, if it be acidulated, therefore it is better to add the acid to the other liquid.

Test (1) a solution of sulphate of iron (green vitriol), as above indicated; first, without adding acid; then, with addition of the acid; and add the permanganate until its color ceases to disappear. Note how sharply defined is the point of saturation of the acidulated iron solution. With large glass jars, the experiment is a pretty one, for parlor recreations of this sort. It is as changing wine into water; but at a certain point (which, after trial with solutions of the same strength, which may be predicted by the operator, or denoted by a line on the receiving jar) the receptive liquid cries, "Hold, enough," and reddens under further infliction. This chemical reaction has long been employed in the volumetric assay of iron.

Test (2) sulphite of sodium, dissolved in water, and acidulated with one of the acids before mentioned, proceeding as in test 1. Observe that the sulphurous odor of the sulphite solution disappears when the purple color of the permanganate ceases to be discharged. The bleaching of the purple stream is in this case even more immediate and complete than in case of the ferrous solution.

Test (3) a solution of oxalic acid. Without acidulation, the oxidation of this substance is slow, and with addition of sulphuric acid it is not so rapid as the oxidation of ferrous salt in test 1, or of sulphite in test 2, but the change is sharply defined at last. This reaction is used in fixing the strength of the permanganate solution, according to weight of oxalic and crystals. Of crystallized oxalic acid, 63 parts will bleach the same volume of permanganate solution that will be required to decolor 356 parts of crystallized ferrous sulphate (free from oxidation). Permanganate is administered in oxaluria, with good result.

Test (4) ordinary alcohol. It will be seen to possess only a very slight capacity for oxidation by permanganate. Then test wood alcohol (pyroxylic spirit). This will be found to oxidize more readily.

Test (5) solution of tannin, and of gallic acid. Which oxidizes the more eagerly?

Test (6) a solution of morphia sulphate, and one of quinia sulphate. Which oxidizes the more easily? Test glycerine, and any materials desired.

Test (7) potable water, for contamination with organic (oxidizable) matter. Note the destruction of the purple color of the permanganate solution at once, upon its addition, and then add enough to give a perceptible red tint to the water and note the paling after one hour; and again, after three hours. Compare samples of water by this test. This method of examination of water for organic contamination was first proposed in 1850, was in a good deal of favor about a dozen years ago, then became the subject of much discussion and objection for inaccuracies, due to inorganic reducing agents and other disturbing conditions, but is now, in the present year, revived with improvements by Dr. Tidy, of London, under the name of the "oxygen process," and bids fair to remain a rival of two other processes now employed by chemists for the same purpose. It is recommended, on good authority, to purify waters with permanganate, in cases where naturally pure waters cannot be had. Add just enough of the purple permanganate solution (not acidulated), so that the color imparted shall remain for 12 to 24 hours before disappearing. Then carefully decant the water from any sediment in the bottom, and it is ready for use.

Try (8) detonation tests with pestle and mortar. Gunpowder can be made, with permanganate as an oxidizing agent, instead of niter. Triturate half a grain to a grain of the permanganate, with a grain of morphia; of sulphur; of pyrogallic acid, using not over half a grain (obtained at any photographer's); with sugar, etc.—*New Preparations.*

A NEW SOLVENT OF PYROXYLINE.

H. BADEN PRITCHARD, F.C.S., of the General Photographic Establishment of the British War Department, says: "M. Nobel, the eminent Swedish engineer, to whom is due the honor of having developed the useful qualities of nitro-glycerine, and applied this valuable blasting agent in the form of dynamite and similar compounds to warlike and industrial purposes, has lately discovered a further quality in the substance. Nitro-glycerine, which is obtained by allowing glycerine to fall drop by drop into strong nitric acid, and thus effecting the nitrification of the glycerine, may be looked upon to all intents and purposes as a liquid gun-cotton, the composition, action and mode of detonation being similar.

"M. Nobel has now brought forward another explosive compound, more violent in its action than gun-cotton or any of the nitro-glycerine preparations hitherto known. He calls it blasting gelatine, but it is gelatine only in appearance, and has none of that material in its composition. The blasting gelatine is, in fact, simply a combination of nitro-glycerine and gun-cotton. M. Nobel does not take the highly explosive cotton—tri-nitro-cellulose—but the less explosive, or collodion pyroxyline, and this he finds is something more soluble in nitro-glycerine than it is in alcohol and ether. Indeed, from seven to ten per cent. of photographer's pyroxyline may be dissolved in nitro-glycerine, the product being, as I have said, a harmonious gelatine mass that is very highly explosive.

"I have made some experiments with this new description of collodion, if the name may be given to it. My sample contained seven per cent. of pyroxyline, and this was iodized with the same solution as that employed for Mawson's collodion. The film, when applied to the glass plate, had more the appearance of thick gum-water than collodion, and was not perfectly set—as well prepared blasting gelatine should be—when put into the silver bath. The result was but an image of the faintest kind after prolonged exposure in a strong light, and, moreover, the picture appeared but on the surface, and not in the film itself, as in the case of an ordinary negative. Repeated experiments did not give more hopeful results, and it was very apparent that the new solvent of pyroxyline has little value to the photographer as furnishing a vehicle for silver salts. To those who desire to experiment further with the compound, I would mention that it is of a very poisonous character, and the mere touching of the film, to see if it has set, with the fingers, is likely to bring about a severe headache. This circumstance should be borne in mind by all who have to do with nitroglycerine preparations.

"But if blasting gelatine is unlikely to find employment in photography, it bids fair to elbow itself to the front for military and engineering purposes. Already, as I have said, its action has proved to be more violent than gun-cotton or dynamite, and recently, since Professor Abel's experiments, a further stride seems possible. That chemist has prepared a more novel explosive still by adding to the gelatinous mass a further quantity of gun-cotton, but this time not photographer's pyroxyline, but the highly explosive trinitro-cellulose. The addition of the latter makes the mass into a kind of white dough, which is more easy to handle than the "gelatine," and which has still more destructive properties; so that the last solvent of pyroxyline is likely to play an important role in the future."

BETONICA OFFICINALIS (WOOD BETONY).

By F. HERRING, M.D., Goshen, Ind.

A FINE description of this valuable new remedy can be found in the January (1879) number of the Chicago *Medical Times*, in which Prof. W. H. Davis fully substantiates my statements regarding its high medicinal properties, having fully tested it in his own private practice, and in his large clinical practice in Bennett Medical College, and expresses himself more than pleased with its results.

I have used it in my own practice for more than ten years, with the most flattering results, and am confident it will win merit wherever it is tried. I know of no other single remedy in the materia medica, that produces such marked results in the treatment of chronic liver affections as this; it promotes the flow of bile, and as a result of this there is an increase of the other secretions; the stools becoming softer and more frequent. It also fulfills a great variety of indications associated with many chronic diseases, being a powerful stomach tonic, promoting digestion and stimulating the secretion.

It has proved very successful in chronic lung affections, when there is a slimy mucous expectoration, accompanied by a tight cough.

It is almost a specific for chronic inflammation of the bladder and kidneys and in all cases of bloody urine, and as it contains no toxic properties it can be used for children equally as well as for adults. Did time and space permit, I might continue enumerating its various other medicinal qualities, but I will defer them until another time.

A short time ago I was called upon to treat Mr. H., aged 35, who had been suffering for a long time with gravel and ulcer in the bladder; he had been treated by several prominent physicians who had regarded his case as hopeless; he had been confined to his bed for about a month previous to my seeing him. He presented a pale and anæmic condition, eyes sunken, tongue coated with dark brown, bowels constipated, appetite poor, and with a constant flowing of bloody urine mixed with pus, the walls of the bladder being evidently considerably thickened. I prescribed a teaspoonful of the fluid extract of betonica officinalis, to be taken every four hours, and an injection of the same to be given morning and evening. After continuing thus for a week, during which time there was constant improvement, I prescribed a teaspoonful to be taken three times daily before meals; continued this treatment for four weeks longer, when I discharged my patient completely cured, the urine presenting a natural color and patient feeling strong and healthy.

The usual dose of the fluid extract is from fifteen to thirty drops three or four times daily. The tincture is equally useful.

ANALYSIS OF COFFEE LEAVES.*

By OTTO HEHNER, F.C.S.

A SAMPLE of roasted coffee leaves, analyzed by W. Stenhouse (Phil. Mag., 4, vii., 21), contained 1·2 per cent. of theine, 2·1 per cent. of total nitrogen, and yielded 38·8 per cent. of extractive matter, the infusion possessing a taste as of tea and coffee combined.

Having recently had a sample of the slightly roasted leaves, as used in Brisbane, Australia, handed to me, I have examined them, with the following results:

Moisture	10·29	
Theine	0·29	
Soluble nitrogenous matter	5·10	Soluble.
Soluble mineral salts	4·95	
Other extractive matter	19·81	
Insoluble nitrogenous matter	13·35	
Cellulose	34·51	
Chlorophyl and other insoluble non-nitrogenous substances	7·83	Insoluble.
Insoluble mineral salts	3·87	
	100·00	
Total extractive matters	30·15	
Total ash	8·82;	of which is
Soluble	3·83	
Insoluble	4·99;	including
Sand	0·42	
Total nitrogen, by soda lime process	3·02	per cent.

The infusion contained much caffe-tannic acid, as well as some tannin and glucose, the latter probably derived from the decomposition of the tannin.

The amount of theine found is remarkably small.

The taste of the infusion, if it can be compared with anything, resembles that of a mixture of tea and tobacco, a taste invariably observed, as I was told by my informant, by habitual consumers of the infusion.

The leaves when burnt or roasted exhale a powerful odor of tobacco, and the vapors, when condensed on a glass plate, smell overpoweringly of tobacco juice. It is needless to add that the leaves were carefully examined with the microscope, and that they contained no particle of tobacco. The microscopic structure of the leaves presents nothing very remarkable, but the sheaths of the veins are most regularly undulated. The stomata are small and numerous.

Mr. J. Hughes said that, having lately visited Ceylon, where he saw Mr. Cotton, who had sent a sample to one of the societies here, he was much interested in the analysis. Coffee leaves had already been prepared and exhibited with a view, if possible, for future use as a drink; the infusion was something like tea, and under some circumstances might be used as a substitute by persons living in the country. It is rather strong, but very refreshing, especially after a long walk or ride.—*The Analyst.*

* Read before the Society of Public Analysts.

AMALGAMS.

AT a recent meeting in Philadelphia, of the Odontological Society of Pennsylvania, the following essay was read by Dr. Charles J. Essig:

"Amalgams" is the name given to any alloy of mercury and another metal. The amalgams form a very numerous class of compounds, and many of them are largely used in the arts.

Some of the amalgams are formed by direct contact of the metals with evolution of heat; others are obtained by the action of mercury on a salt of the metal, or the action of the metal on a salt of mercury, assisted by the passage of a weak electric current in some cases.

Some amalgams are solid, others liquid. They are, generally speaking, weak compounds, many of them being decomposed by pressure, and all at high temperatures. Alloys for dental amalgams should possess the qualities of strength and sharpness of edge, and freedom from admixture with any metal capable of forming soluble salts of an injurious character in the mouth. It should also be capable of maintaining its color, although in an alloy composed of several different metals absolute freedom from discoloration, under the conditions to which an amalgam filling is exposed, cannot readily be obtained. It should also be capable of retaining its shape, as the tendency on the part of many amalgams to assume a globular form after their introduction, thus leaving the edges of the cavity unprotected, is probably a prolific cause of failure in this class of filling. Undue expansion, although not so likely to occur as some other conditions, would be equally a source of failure. According to Mr. Fletcher, amalgams of silver and mercury alone expand sometimes sufficiently to split a tooth, and Mr. Kirby states "that amalgams of pure silver, either the precipitate or filings, expand greatly;" with a suitable instrument for measuring he was able to determine the change in bulk of such an amalgam, in which he found the extent of expansion to reach one-fortieth of its diameter. Many old amalgam fillings have the appearance of projecting from the edges of the cavity, as though there existed some force behind or under sufficient to push them out. There seems to be some diversity of opinion respecting the cause of this, and, while it has been attributed to expansion, others have believed it to be due to the opposite condition. Favoring the latter theory, Mr. Fletcher states that he has found it only with those amalgams which are known to shrink, and he suggests that the plugs may be raised, or forced out, by the "decomposition of tooth-substance and formation of gas under the loosened plug, the driving down and accumulation of food underneath, or some similar cause." It is evident that an amalgam possessing to a marked extent either property is not to be relied upon as a filling material; and both may cause the condition above referred to.

Discoloration of dental amalgams depends largely upon the formation of sulphides. The fluids of the mouth, in every case where the most scrupulous cleanliness is not observed, may be said to contain sulphur in combination with hydrogen, as dihydric-sulphide (H_2S), resulting from decomposition of particles of food lodging between and adhering to the teeth. The affinity of sulphur for both silver and mercury is so active that we may reasonably assume that not only the discoloration of amalgam filling, but in many cases their failure to prevent a recurrence of decay, is due to the action of that element upon the alloy. Neither is it safe, in compounding alloys for dental amalgams, to depend upon the protecting influence of metals which do not possess the same affinities, such as gold and platinum, for while these metals individually may remain wholly unaffected by contact with sulphur, it does not necessarily follow that their presence in an alloy will confer the same immunity upon such as silver and mercury. Indeed, the reverse of this may take place; and those which are totally insoluble in certain menstrua may be rendered soluble in them, by the addition of a metal on which they have the power of acting. In this way platinum, although of itself invulnerable to nitric acid, may be dissolved by it when sufficiently alloyed with silver. There are doubtless other causes for the discoloration of amalgams, some of them purely adventitious, depending upon the administration of certain remedies in disease, abnormal conditions of the fluids of the mouth, or the presence of vegetable acids in articles of food.

An amalgam filling may retain its integrity of surface, while at the same time the darkening of the tooth-substance unmistakably indicates chemical action at its peripheral portion, due to imperfect adaptation favoring the ingress of the eroding agent. It appears that almost any amalgam filling may be kept bright by attrition, whether of the brush or in mastication, and it seems equally certain that all amalgams will blacken, if the position which the filling occupies protects it entirely from friction. Again, an amalgam filling may retain its original color and brightness of surface and yet not protect the tooth; and, conversely, a filling of this class may exhibit a great degree of surface discoloration and yet fully preserve the tooth from further decay, peripheral discoloration being much the worse condition of the two.

In a number of experiments which I made with some of the well-known amalgams, such as Townsend's, Arrington's, "Standard Alloy," Lawrence's, Walker's, etc., as well as with some of a higher grade of my own compounding, consisting of gold, silver, tin, and platinum, I found that, with care in using the proper quantity of mercury and in packing the mass into clean glass tubes, which were then filled with colored fluid and closely sealed, apparently, after several weeks, not the slightest leakage occurred, and yet, when the same tubes were thrown into a solution of sulphureted hydrogen, the edges were attacked, and marked discoloration occurred, while the surface directly exposed to the action of the sulphur, and not in contact with the glass, was but slightly clouded. The edges had the appearance of having been eroded as by an acid. This experiment is not merely speculative, since it simply consists in filling a cavity with amalgam and then exposing it to sulphur in the form usually found in the mouth. The result is precisely similar to that which is observed in the great majority of amalgam fillings in actual service. It would seem, however, that the purely theoretical test of covering the plug with colored fluid, such as indigo, blue ink, etc., known as the "color test," is not to be relied upon in testing peripheral adaptation, for all the plugs used in this experiment had, apparently, excluded the passage of the coloring fluid. Yet that they did not perfectly seal the tubes, although introduced under very favorable conditions, was abundantly shown by the result, which plainly indicated that solution of one or more of the constituents of the alloy had taken place, resulting in the formation of new compounds, consisting of sulphides of silver and mercury, and in some instances probably of copper.

Properties conferred by the different metals usually present as constituents of amalgams.—Tin dissolves very easily in mercury, but it hardens slowly and imperfectly. Without admixture with other metals it is unfit for use in the mouth. It is also well known to possess a tendency to draw away from the edges of any cavity into which it may be packed, and to assume a globular form. It never becomes sufficiently hard to answer the requirements of a filling material. Mixed with other metals, tin serves as a vehicle by which amalgamation is facilitated and different degrees of plasticity obtained. For example, between mercury and silver these phenomena are more slowly manifested; by the addition of tin, however, both properties are easily attained.

Silver, apparently, unites very readily with mercury, yet it will be found, upon close examination, that complete solution of pure silver filings does not take place until after some weeks of contact, unless the silver in a finely-divided state be added to heated mercury, when amalgamation will be more readily accomplished. Amalgams of silver and mercury alone are said to expand. Silver, with tin added, yields an alloy very white in appearance, but more easily oxidized than either of the constituents; mixed with mercury an exceedingly unctuous and plastic amalgam is obtained, but it is somewhat slow in hardening, and there is much diversity of opinion in regard to the contraction and expansion of this alloy.

Dr. Hitchcock and Mr. Tomes both claim contraction* for it, while Mr. Kirby states that an "amalgam consisting of an alloy of three parts of silver and two of tin contracts slightly at first, but finally expands about $\frac{1}{150}$."† These variable results may depend upon the quantity of mercury employed; and I am satisfied that when an alloy of silver and tin is used no excess of mercury should be present, and when this precaution has been carefully observed, it has been found that the result is quite as good as those obtained with alloys of a higher grade. Thus, five hundred milligrammes of Arrington's amalgam, composed of silver, forty per cent.; tin, sixty per cent.,‡ mixed with one hundred and sixty milligrammes of mercury, withstood the sulphureted hydrogen test quite as well as those containing gold and platinum. It should be borne in mind that alloys composed of tin and silver only require much less mercury to render them plastic than those containing additional proportions of gold and platinum.

Probably the most unfavorable condition observed in alloys of silver and tin is slowness in hardening, thus favoring the ingress of fluids by capillary force. The direct influence which silver exerts upon amalgam of tin and mercury, when added to it, is to lessen the tendency to assume the spheroidal form, and to facilitate setting. In this respect its action is similar to that of gold; but while the latter further lessens these injurious tendencies and confers analogous properties, it cannot be made to supersede silver. In my first experiment with these curious compounds I formed an alloy consisting of

Gold	500	milligrammes,
Platinum	500	"
Silver	2,000	"
Tin	2,500	"

An amalgam of this alloy hardened almost instantly, so that a filling of it might be inserted and finished at one sitting. For the sake of experiment I made another ingot, omitting the silver; the result was an exceedingly brittle alloy, which could only be made to unite with mercury by heating, and even then with difficulty, and after many days, it had not hardened sufficiently for use as a filling material. Thus it will be seen that silver fills an important place in dental alloys, since without its presence amalgamation becomes difficult, and the valuable property of rapidity in hardening is lost.

Gold combines with mercury at all temperatures, but for rapid amalgamation an elevation of temperature is required, and the process is further accelerated by a state of fine division. With mercury alone it does not harden well; added to tin, it to a certain extent facilitates setting, but does not harden sufficiently for use in the mouth. Gold prevents the tendency to draw away from the edges; but when added to an alloy of tin and silver the greatest benefit is derived from its presence. I found that an alloy consisting of

Gold	500	milligrammes,
Silver	2,000	"
Tin	2,500	"

when mixed with mercury in the proportions of five hundred milligrammes of the alloy to two hundred and fifty milligrammes of mercury, retained its sharpness of edge, hardened well in a few minutes, and apparently filled all the requirements of a dental amalgam. I am aware that it has been stated that gold added to an alloy of tin and silver retards hardening, but I suspect this to be an error, and the presence of an excess of mercury the real cause.

Platinum, in the form of plate or wire, does not unite with mercury. A very smooth and plastic amalgam may, however, be formed by rubbing some finely-divided platinum, such as is obtained by precipitation with mercury in a heated mortar.

An amalgam composed of platinum and mercury alone does not harden well. The properties of an alloy of tin and silver are also greatly impaired by the addition of platinum. I found an alloy consisting of tin two thousand five hundred milligrammes, platinum five hundred milligrammes, to be exceedingly brittle, and with its affinity for mercury lessened to such an extent that amalgamation was only accomplished by elevation of temperature and much rubbing, while the property of setting was almost entirely lost.

Added to an alloy of gold and tin, the same negative results are observed (see silver); when combined with tin, silver, and gold, however, the real value of platinum becomes apparent; with the proper amount of mercury it seems to confer upon such an alloy the property of almost instantly setting, as well as greater hardness. Thus it will be seen that the qualities claimed for platinum *per se* belong in reality to the combination of tin, silver, gold, platinum, and mercury, since, if any one of the others is omitted, the platinum not only remains passive but actually, by its presence, causes marked deterioration of the qualities essential in a dental amalgam.

Alloys containing platinum amalgamate less readily than those wherefrom it is absent; yet, when union has once begun, they seem to require a greater amount of mercury to render them plastic. By careful experiment I found that with an alloy of

Platinum	500	milligrammes,
Gold	500	"
Silver	2,000	"
Tin	2,500	"

the smallest amount of mercury which could be employed, without impairing the strength and general working qualities of the amalgam, was three hundred milligrammes of mercury to five hundred milligrammes of the alloy; while with another ingot, composed of

Gold	500	milligrammes,
Silver	2,000	"
Tin	2,500	"

one hundred and sixty milligrammes of mercury to five hundred of the alloy afforded a perfectly good result.

The proper quantity of mercury should be ascertained by careful experiment. The statements of manufacturers or vendors are not always reliable, if we may judge from the directions accompanying one particular compound, modestly called "The Standard Alloy," in which the proportion of mercury to the alloy is given as five to six—an amount so greatly in excess that I found, in filling a tube with a mass composed of six hundred milligrammes of the alloy with five hundred milligrammes of mercury, that more than a third of the latter was expressed with very slight force.

In order to ascertain the amount of mercury required by different alloys, a small quantity of the latter should be taken, say one gramme, and, after weighing, the mercury may be carefully added, and mixed by rubbing until the mass assumes a semi-cohesive state; it should then be weighed again, to determine accurately the amount of mercury present; and may then be introduced into a glass tube and condensed by means of instruments slightly warmed. Should the proportions not be correct, another trial may be made, and the quantity of mercury increased or diminished, according to the result of the first experiment.

The quantity of mercury required by different alloys is probably definite, so that a tolerably accurate approximation of the composition of an alloy may be arrived at by carefully noting the required proportions of one to the other.

Different means are employed in the attainment of this object; probably the most common is to mix the alloy with a large excess of mercury, and then to express the surplus either by compression with the fingers, or through the pores of a piece of chamois-leather; the first involves a loss of some of the alloy, which is carried away with the surplus of mercury, and neither of them is to be relied upon as a means of excluding an excess of mercury.

There are also several methods employed in mixing amalgams. Probably the most common one consists in simply rubbing the two together in the palm of the hand; this is certainly the most expeditious, though not a very neat way, and much has been said about manifestations of the physiological effect of mercury following a long continuance of the practice. I have been to considerable trouble to ascertain the correctness of this theory, and while I have met some who have attributed certain phases of ill health to absorption of mercury applied in this way, yet I have been unable to directly trace a single case of ptyalism or any other well-marked sign of mercurial poisoning to this cause. It would be well to remember, however, that the active properties of mercury are developed by a state of fine division, and there is nothing unreasonable in the belief that mercury highly comminuted by rubbing in the palm of the hand may find its way into the system and produce constitutional disturbance. In view of these facts it would be a proper precaution to prevent contact of mercury with the skin; this may be accomplished by covering the hand with a piece of rubber dam, forming a sort of mitten, leaving the fingers free, and having an opening for the thumb to pass through.

Small porcelain mortars are also employed in amalgamation, but they do not speedily effect the desired purpose, in consequence of the granules of the alloy becoming burnished by the attrition of the pestle; heating the mortar will, however, greatly facilitate union.

Mr. Fletcher has recently called attention to a simple and effective method of mixing amalgams. The required weights of filings and mercury are put into a long, narrow test-tube, or bottle, and well shaken for a few seconds; the percussive force brought to bear upon the mass quickly promotes union.

Some difficulty may be encountered in introducing amalgam fillings where the mercury has been reduced to the minimum; the semi-coherent mass, almost in the form of a powder, is not easily introduced into the cavity, especially if it be in the superior arch, and the only way by which it can be conveyed to the cavity is by first compressing some of the powder with a warm instrument, after which it may be handled with the pliers.

Fletcher has recently devised a sort of cylinder mould by which amalgams, mixed so dry as to be unmanageable, may rapidly be shaped into a convenient workable form; it consists of a cylinder into which the semi-coherent mass is poured, and by means of a piston the powder is compressed into disks of the desired thickness, which may be introduced into the cavity and solidly compressed with slightly-warmed instruments. It is claimed that this arrangement practically does away with the chief objection to the use of very dry amalgams.

Alloys.—Most of the metals are capable of uniting with each other, forming a class of compounds termed alloys, in which may be observed, to a greater or less extent, the properties of the several constituents entering into the union.

From a purely scientific point of view the study of the alloys is an interesting one, as they are not only mixtures of metals possessing certain distinct qualities, but may also be regarded as true chemical compounds, as in the appearance which often accompanies the union of the metals and in the properties of the resulting alloys we may frequently observe the phenomena which characterize affinity, such as heat and incandescence, resulting in the formation of substances having a definite composition, distinct crystalline form, and properties differing from those of their constituents.

The tendency on the part of metals to unite in definite proportions may be studied in connection with platinum, iridium, gold, rhodium, ruthenium, and silver, when fused with tin. If the latter metal is in excess after cooling, a metallic ingot is obtained resembling closely the original substance; but by the action of strong hydrochloric acid the excess of tin may be dissolved, leaving crystals of a definite alloy of the tin and the noble metal, which cannot be further dissolved by the same acid, but are soluble in the hydrochloric acid even when the precious metal contained, whether rhodium, ruthenium, or iridium, is in the free state absolutely insoluble.

It must not, however, be assumed that all the alloys employed in the useful arts are the result of one definite combination, many being capable of co-existing in the same alloy; this accounts for the difference frequently observed in the behavior of different parts of the same ingot, and may be demonstrated in an alloy of tin, lead, and bismuth, which melts below the boiling point of water, heated to 20° C., and then permitted to cool; it will be observed by the assistance of the thermometer that the fall of temperature is twice distinctly arrested, and the cause of this phenomenon has been assumed as due to the production in the compound of a less fusible alloy, which, in solidifying, evolves heat, and thus for a time retards the gradual cooling of the mass. It may therefore be assumed that true chemical combination may occur between two metals, notwithstanding the fact that such union may be masked by excess of one of the constituents.

Matthiensen, in an elaborate paper on the subject, states that "An alloy may be, 1st, a solidified solution of one metal in another; 2d, a chemical combination; 3d, a mechanical mixture; 4th, a solidified solution or mechanical mixture of two or all of the above."

Forming alloys for amalgams.—The putting together of the constituents of an alloy composed of tin, silver, gold, and platinum, is a matter of no great difficulty, as it does not require an extraordinary degree of heat, and it may easily be accomplished in a stove or furnace such as usually employed for heating or cooking purposes; the small reverberatory furnace, recently devised by Mr. Fletcher and manufactured by the B. D. M. Co., answers very well. I have used one successfully in a large number of melting operations; and they cost but a small sum. The only difficulties likely to be met with in forming an alloy of this description are oxidation of the tin, and the formation of certain definite compounds having a tendency to separate from the mass, thus affording an ingot which is not homogeneous.

Oxidation of the tin may take place at the instant of union with the platinum when a great elevation of temperature occurs; for this reason the platinum should not be in a too finely divided state, as a condition of minute division greatly accelerates combination, and consequently increases the intensity of the accompanying phenomena of heat, etc. A quantity of borax should be fused in the crucible before the metals are melted, the object being to prevent adhesion of the alloy to the sides, to facilitate pouring, and to dissolve and hold in solution any oxide which may be present. Lastly, a layer of broken charcoal should be placed over the mass before heating; this will perfectly protect it from oxidation.

The formation of definite alloys, it has been shown, takes place with the gradual cooling of the mass, the fusing point and density of these being greater than that which remains fluid. They manifest a tendency to settle to the bottom of the crucible in a solid state, and in some cases do not leave the crucible in pouring; thus the ingot may not possess the desired composition. Again, they may assume a semi solid form, floating in masses in the more fluid portion, and setting at the moment of pouring at the bottom or sides of the mould, the result yielding an ingot which is not uniform in composition. In consequence of this it has been recommended that different parts of every ingot should be tested; but this difficulty may be entirely avoided by carrying the heat to a point of complete fusion, and pouring while still very hot, before the tendency to separate begins.

Oxidation of the surface from contact with the atmosphere will retard amalgamation. It is therefore better not to reduce the entire ingot to a state of fine division. It will be found to unite more readily with the mercury if freshly filed off as required for use; this can easily be effected with one of the coarse files sold at the depots as vulcanite files. Other metals such as palladium, copper, cadmium, bismuth, antimony, and even zinc, have been used as constituents of amalgams. The four latter are of but little value, and some of them are liable to be converted into salts of a deleterious nature. Palladium confers similar properties to those obtained by the addition of platinum; but it is a rare and expensive metal, and is probably in no respect superior, as an ingredient in dental alloys, to platinum.

Copper is said to control shrinkage while it increases the tendency to discoloration. Most dentists would hesitate about employing an amalgam known to contain copper; yet I was much surprised recently at the result of a careful analysis of an amalgam filling which had done good service for

* Transactions New York Odontological Society, 1874.
† Ibid. ‡ Hitchcock, Ibid.

twenty-three years, during which period it had retained a perfectly bright and smooth surface exteriorly. Having become loose by the fracture of a portion of the tooth, involving one retaining wall, in consequence of the gradual softening of the dentine, the patient brought it to me, and I found its composition (after freeing from mercury) to be tin, 55 parts; silver, 40 parts; copper, 5 parts.

Brittleness may be increased or diminished according to the quantity of platinum present, and the resulting amalgam will exhibit this quality equally with the alloy. An amalgam filling should always be strong enough to retain its integrity of edge under the force of mastication. The formula from which I have obtained very good results is as follows:

Silver	40 grammes.
Tin	60 "
Gold	3 "
Platinum	3 "

Larger percentages of gold and platinum afford no better results, but, on the contrary, the alloy is rendered more brittle thereby; its affinity for mercury is lessened, while its capacity for the latter is increased, as shown under the head of platinum.

DISCUSSION.

Dr. Darby—Dr. Essig has failed in his essay to refer to the proper method of alloying the metals, and much depends upon this. The silver should be melted first, and when at a boiling heat the platinum should be added in very small particles—either rolled into thin ribbons or cut into minute pieces. Next, the gold should be added, and lastly the tin. When the mass is thoroughly melted, it should be well stirred, and immediately poured into the ignot mould. If this method is not followed there is danger of the platinum falling to the bottom of the crucible, and it will be found that the alloy is minus the platinum.

Dr. Essig—Dr. Darby refers to the putting together of the metals. Between tin and the metals of the platinum group strong affinity exists, and when melted together tin and platinum combine with such avidity that incandescence accompanies the union, and it is only necessary to expose the two under favorable condition to a temperature of 600° F. The platinum does not settle to the bottom of the crucible in consequence of its greater specific gravity; that appearance is probably due to the formation of alloys of definite proportions as the mass cools. The way to avoid this trouble is to pour the alloy while still very hot, and before these formations take place. There will be no oxidation of the alloy if kept covered with fine charcoal during melting. I am using an alloy composed of tin, 3 oz.; silver, 2½ oz.; platinum, 2½ dwts.; gold, 2½ dwts. (Dr. Essig presented several specimens of exceedingly hard amalgams in glass tubes, the hardest of which, he said, was composed of silver, gold, platinum, and tin.)

Dr. Tees—For the past eleven years I have experimented a great deal with these alloys for amalgam, and I have found that good results can be obtained with silver and tin alone. Dr. Flagg told the proprietors of one of the dental depots that Townsend's amalgam, composed of five parts of tin to four parts of silver, was as good as any. A quick setting amalgam may be made from an alloy of four parts of silver to three parts of tin; but it makes a filling of a darker color than one made from an alloy in which tin is in excess. For many years I used an alloy composed of five parts of silver to three parts of tin. About seven years ago I filled for one of my patients several very large cavities with amalgam of this alloy; the fillings are still in good condition and of a fair color. For the past three or four years I have been using an alloy composed of 40 dwts. of tin (chemically pure); 24 dwts. of silver (chemically pure), 1 dwt. of platinum filings.

I place the silver and the platinum filings together in a crucible, with a small lump of borax, and melt in a hot coke fire. Like Dr. Darby, I allow them to boil for fifteen or twenty minutes. I then melt the tin in another crucible and pour the boiling silver and platinum into it, and immediately pour the mass into an ingot mould.

It has been recently asserted that the platinum in the alloy does not unite chemically with the other metals, but having a mechanical union only, is lost with the oxide in the process of amalgamation. As a proof that this is not so, we find that an amalgam filling, formed from an alloy in which platinum is a constituent, is of a different character from one of the same proportion of the other metals, but containing no platinum.

In regard to ptyalism or other constitutional disturbances being produced by mixing the amalgam in the palm of the hand, I must say that I have been mixing it in this way for many years, and almost daily for the past ten years, and still I am enjoying excellent health.

Dr. Kingsbury.—In 1838, when I first used amalgam, it was prepared by filing the ordinary silver coin and amalgamating it with crude mercury. The result was a somewhat granular but very hard amalgam, that soon became dark colored from oxidation. The proportion of copper in the silver coin doubtless increased its tendency to oxidize. After a time a portion of tin foil was added to the amalgam, which was regarded as an improvement, although the coin and the tin were not melted together as now to form an alloy previous to filing and amalgamating with the mercury. The first fillings of this kind that I ever saw were in the mouth of a clergyman, and in the proximate surfaces of the inferior incisors, which were badly decayed. The fillings were quite dark colored and unsightly; yet the patient appeared much pleased with them.

For two or three years I used amalgam in filling badly decayed teeth, and with great satisfaction to my patients. Some prominent dentists took strong grounds against the use of it, alleging that it produced ptyalism in some cases. Some fatal cases were reported (notably one that occurred in Springfield, Mass.) as resulting from its use, and a strong prejudice was created against it. My judgment was overruled by the older practitioners and I abandoned it altogether, and did not use it again until the amalgam war was ended, and a revolution or change of sentiment took place in favor of its use in special cases. I have used it to a limited extent in my practice ever since. I believe it to be valuable as a filling material when used with proper care and discrimination.

Since my residence in this city I have used a variety of amalgams—more of Townsend's and Arrington's probably than any other. In conversation with Dr. Flagg recently on the relative merits of the different amalgams in use, he remarked that from his experience and the special attention he had given the subject he was led to believe that the old amalgam made from silver coin, with its small proportion of copper, so far as its chemical constituents are concerned, was just about what was needed.

Dr. Atkinson, of New York. I do not know that I can add anything to what has already been said, except to suggest that the alloy, while in a state of fusion, should be poured into a tank of water, and afterwards, if necessary, remelted and poured into an ignot mould. I would not criticise the rest of the paper without being sure that I thoroughly understood it. Those who opposed the use of amalgam without reason, accepted it at last after the persistent efforts of those who strove after the truth; but these are not the ones who should lead the world. Experimentation is what is necessary.

ORANGE FLOWERS AND ORANGES.*

By W. B. BUSH.

IN Florida, the orange, lemon, and lime grow wild, and are found in abundance. In Louisiana and Mississippi they are grown from the seed. The seeds are planted in early spring, or in hot-beds in January. When one year old, they are transplanted in a nursery arrangement. At the age of two and a half years, they are budded, *i.e.*, the seedlings are of the sour variety, and, to produce sweet oranges, fully matured buds are taken from bearing trees and inserted. This is done to render the tree more hardy, since the sweet seedlings are subject to a root disease called heel, while the sour seedlings are not. Hence, orange growers resort to this means to produce sweet oranges. The trees are transplanted, at the age of four years, into orchards. At the age of six, flowers first appear, and at ten years the trees are called full bearers.

This beautiful evergreen is found in every civilized country where the climate is favorable, and in colder countries it is the cherished ornament of the hot-house. It flourishes in the most southern limits of the United States, largely in Florida, and to a considerable extent in Mississippi and Louisiana, south of the lakes. In Mississippi and Louisiana they are favored by the lakes tempering the cold north winds. There seems but little difference between these States in their favorable localities. However, the tree requires delicate cultivation and studied treatment. About the year 1816, oranges were introduced as ornaments to the States by the French. In 1830 an orange tree in a box, in bloom, brought 400 francs, and about this time some attention was paid by horticulturists, and blooming trees in boxes were sold at from 50 to 100 francs in New Orleans. The beginning of the cultivation of oranges for fruit, in the South, dates back to 1848, when numbers of trees were planted, but in January, 1856, a cold wave from Texas brought the temperature down to 10° F. above zero, and a large proportion of the trees were killed. Not much attention was paid to the cultivation afterwards until 1867 and 1868, and since then orange growing has been quite successful, and assumed commercial importance.

The time of flowering is from the beginning of February until the 10th of April, in healthy trees; unhealthy ones are found in bloom sooner or later. The last week of February finds most of the trees blooming. The petals remain on the flowers for about two weeks. Unfavorable conditions shorten the time. The humidity of the atmosphere materially affects the flowers—when too wet the pollen heads are injured and the secretions are imperfect. Dryness has a similar effect on the pollen and nectar, but does not affect the secretion of oil. When the temperature is too low but few flowers are fructified, the oil cells are limpid, and no nectar is secreted. The most favorable temperature is about 68° to 76° F. Under 60° F. flowers are blighted. When the busy bee is found collecting the nectar, the conditions are favorable for the development of flowers and fruit, and then the flowers contain their most agreeable odor.

An ordinary tree will yield from two to ten pounds of flowers, ordinarily about seven. As soon as the petals begin to fall a canvas is spread under the tree, and by brisk shaking the petals will fall, with some leaves, which are easily separated. The time when flowers are most fragrant is early in the morning, and late in the day the odor is greatly diminished. Prior to the late conflict negroes collected and sold orange petals in New Orleans. A tea-saucer full (2 oz.) was measured out, put upon a china plate and set in the room, for which the negro received about 50 cents. From two to three plates would perfume a room for a week. Orange flowers produced in the extreme southern borders are believed to possess a stronger odor and more oil. The difference is accounted for in this manner: In the tropics and semi-tropics the trees do not begin to bear very much until about 20 years old, while in this country they begin at about seven. The development is more rapid, the tree more vigorous, and it is reasonable to suppose a better development of odor in the flower. The writer was informed by an orange-grower who had made extensive observations in different countries, and fully confirmed this supposition. The flowers are more fragrant, and the fruit more juicy, but not so sweet as in some other countries.

The United States pharmacist buys the products of the orange from over the sea. That name "imported" always adds an imaginary value of more than 100 per cent. It is said to pay the producer of California wines to send his wine to France, and, having the label changed and translated into French, bring it back here, pay freights and double duty, and then realize 100 per cent. on the transfers, because the consumer considers it far superior to our wine. Just so with our neroli, and the orange flower water, and fruit juices. Almost all the crude material for citric acid is imported. This need not be. There is abundance to be had in the South. Florida furnishes flowers sufficient for America for the oil of neroli, orange flower water, citric acid, fruit juice and oils of the rind, and if no misfortune happens to the sweet orange plantations, there will soon be fruit sufficient for the United States from the 1st of November until May.

The writer made several experiments with orange flowers. When placed in direct sunlight, in the course of two days they lose all their odor. In diffused daylight they retain it for at least three days, and in a dark humid atmosphere the odor is quite distinct after one week. When bruised, they lose their odor in half of the time stated. The writer had no means for experimenting as to the amount of volatile oil, but he believes that the better plan for the pharmacist is to have the petals hermetically sealed and to make his preparations direct.

Orange-flower water is one of the most agreeable vehicles for nauseous medicines that we have, and when the pharmacist can make fresh preparations, they will be fully appreciated and the expense will not be greater. The sirup of either flower or fruit has no superior, especially the sirup of the fruit. A honey collected from orange flowers is very fragrant with the orange odor. The flowers, placed in tin cans and sealed up are known to have retained their odor unimpaired for nine months. As a perfume they have no equal. To sit under a tree when in full bloom is delightful, the fragrance intoxicating. If any one has made the sirup of orange from the fresh juice of the fruit and used it, he will not want to use any more which is made from simple sirup and a few drops of the oil of the rind.

* From a paper read at a meeting of the Philadelphia College of Pharmacy, January 31, 1879.

PROPAGATING RARE PLANTS.

By THOMAS LAWRENCE, Ogdensburg, N. Y.

THERE may not be anything new in the following method of propagation; still, as I never saw or heard of it before hitting on it, I thought there might be some of your readers like myself:

It is nearly always desirable to increase new plants, and plants of slow growth, faster than they furnish wood for the purpose. It can be increased from two to ten fold by commencing at the point of a well established plant, and, splitting it downward an inch or more according to its nature and growth, leaving it in that condition for a day or two. Then commence at the point of these halves, and split them down into quarters. Leave them from two to ten days to callous, when each quarter will make a cutting almost certain to grow, even if cut into single eyes. As soon as the cuttings have rooted, been potted, and well established, split them also half their length, and in a few days more continue the split down to and through the roots, making two or more plants instead of one.

I find it advantageous with tricolored geraniums, double primulas, etc. It does not endanger the life of the parent plant, for they can be taken off a few at a time, thereby lessening the shock that would occur to some plants if the whole top were taken at a sweep. The parent plant goes right on growing, without the necessity for repotting. The young growth of most hard wooded plants might be facilitated in the same way. There is no rotting in the cutting bench, as is often the case with whole cuttings of tricolor geraniums, poinsettas, etc.—*Gardeners' Monthly.*

CURRANTS FOR PROFIT.

I FIND that nothing pays better than currants. The majority of people will not be at the trouble of dusting the bushes with a little hellebore, thus losing their fruit; yet nearly every one needs and will have a few for jelly, jam, or for immediate use. The peculiar acid is invaluable in hot weather and almost every one craves it. I had no difficulty in selling all I can raise at four dollars per bushel. At three dollars they abundantly pay. It is desirable to plant the white in preference to the red varieties, as they are not seen by the birds. The most profitable varieties I should set down in the following order: White Dutch, Versaillaise, Cherry, Victoria. The ground should be well drained in order to prevent frost-heaving, as the bush is easily pried out when there is much freezing and thawing, with little snow. My plan is to set the bushes in rows about ten feet apart, and six feet in the row. Between the rows corn or any hoed crop may be planted. In the rows plant beans or potatoes. Cultivate and hoe the whole ground. Always slightly hill the currants at the second or last hoeing. It is a good plan to have a patch of gooseberries near the currants. The worms will appear first on the gooseberries, and can be promptly disposed of with two dustings of hellebore. They will not then appear to any extent, if at all, on the currants. It is best to apply the hellebore when there is dew on the bushes.—*E. P. Powell, in the Rural New Yorker.*

ANDA AND OIL OF ANDA SEED.—*Anda Brasiliensis* Radde (*Anda Gomesii* Juss., *Johannesia princeps* Velloz) is a tree indigenous to Brazil, belonging to the native family of Euphorbiaceæ, the bark of which, when incised, exudes a milky juice used for poisoning or stupefying fish. The fruit of the tree is over three inches in diameter, containing seeds of the size of a chestnut, which have a pleasant almond-like taste and contain a fixed oil, which is a cathartic and sometimes also acts as an emetic. One or two are sufficient to produce copious evacuation. In Brazil they have been used from ancient times for this purpose, generally triturated with sugar, cinnamon, and anise. The fixed oil, obtained by expression, has a pale-yellow color, is transparent, and almost tasteless.—*Restaur. Farmaceutico.*

A NEW INSTRUMENT FOR THE MINERAL ANALYST.

AT a recent meeting of the Philadelphia Academy of Natural Sciences, Professor Koenig, of the University of Pennsylvania, exhibited what he calls a chromometer (or color-measurer), a new instrument he has designed for making exquisitely delicate determinations of the presence of certain metals in ores. It is based on the optical fact that complementary colors will extinguish each other if mixed in proper proportions; *e. g.*, if to a green solution a red solution be added in suitable proportion, the liquid will become colorless. Professor Koenig has applied this principle to the colors which certain metals, as iron, manganese, copper, etc., produce when fused with borax, the only chemical used in this method of analysis. He prepares such glasses or beads containing known quantities of a metal in one hundred parts, and observes how thick a glass of the complementary color must be to produce extinction. This chromometer is furnished with a glass wedge of a green or red color, cut at an angle of about one degree. By moving this wedge before the glass bead, with the help of a suitable rack movement, a scale is moved at the same time, and when the point of extinction of color is arrived at, the reading of the scale refers to a table showing a percentage of metal contained in the examined substance. By this method of analysis a correct determination of manganese in iron ore can, it is said, be made in fifteen minutes, which is not more than one-third of the time required by the usual methods of analysis.

DECOMPOSITION OF CALCIUM CHLORIDE BY WATER.—H. C. Dibbits.—Crystalline calcium chloride ($CaCl_2+6H_2O$) loses in dry air, even below 10°, five molecules of water, the first four of which escapes readily and the last much more slowly. At 80° the salt becomes completely anhydrous in dry air. When the salt loses all its crystalline water at a temperature not exceeding 130° no appreciable loss of hydrochloric acid takes place. Between 130° and 140° the escape of acid becomes perceptible. The more the temperature rises the more hydrochloric acid escapes, still even if gently heated over a naked flame the decomposition is so slight that not more than 0·03 per cent of the acid is lost. Even at 150° the loss is so slight that it remains entirely within the ordinary limit of error.